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Index to Advertisers and Classified Index Following Reading Matter.

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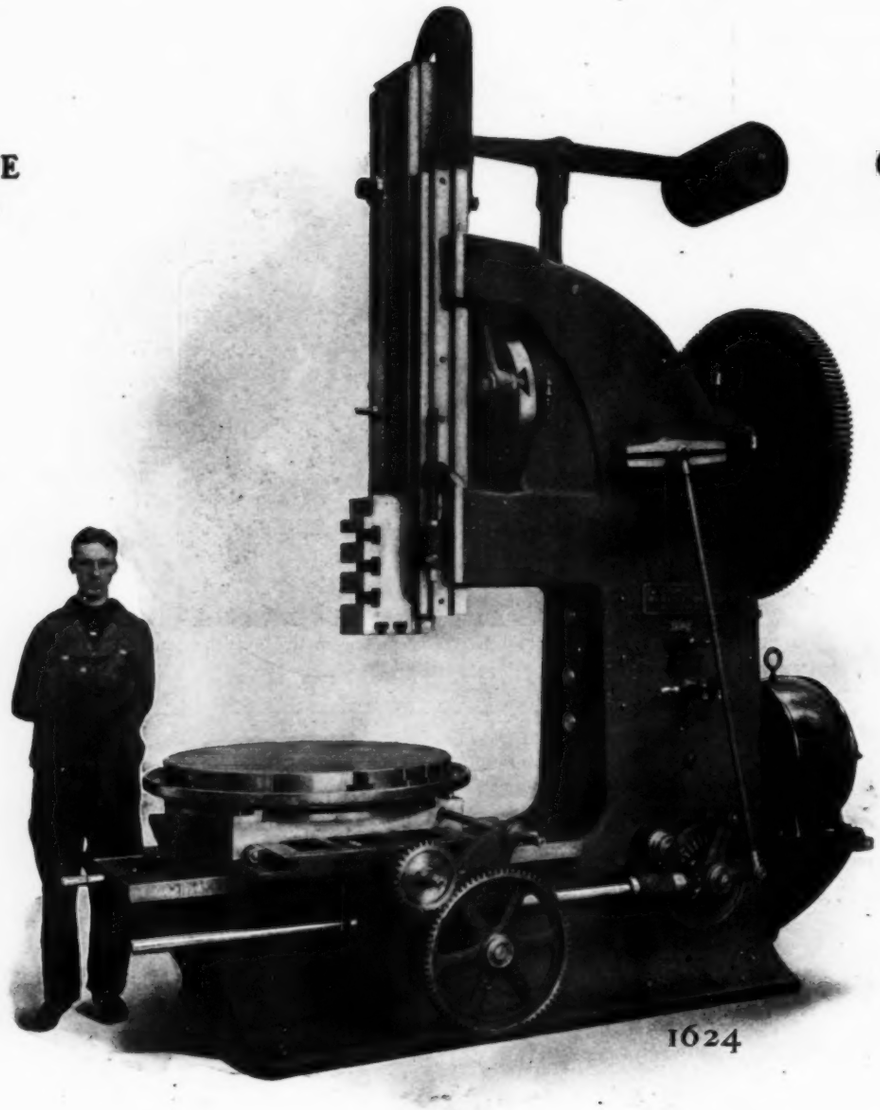

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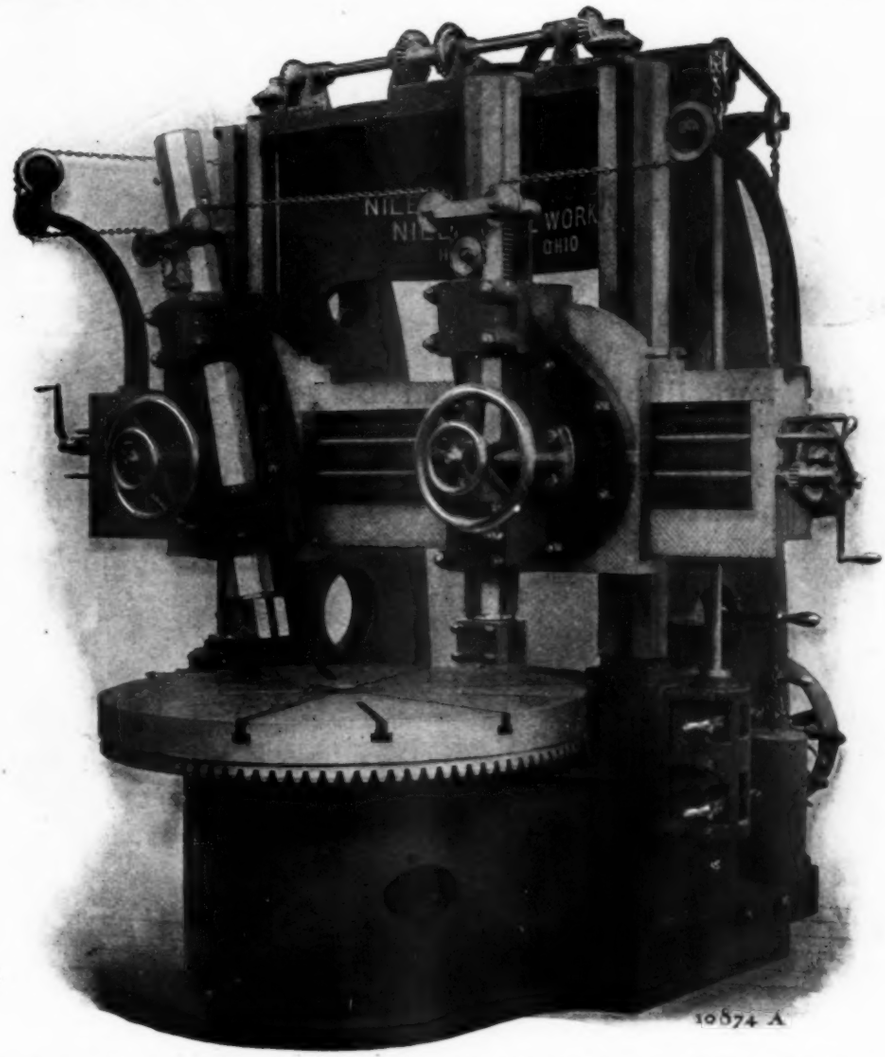

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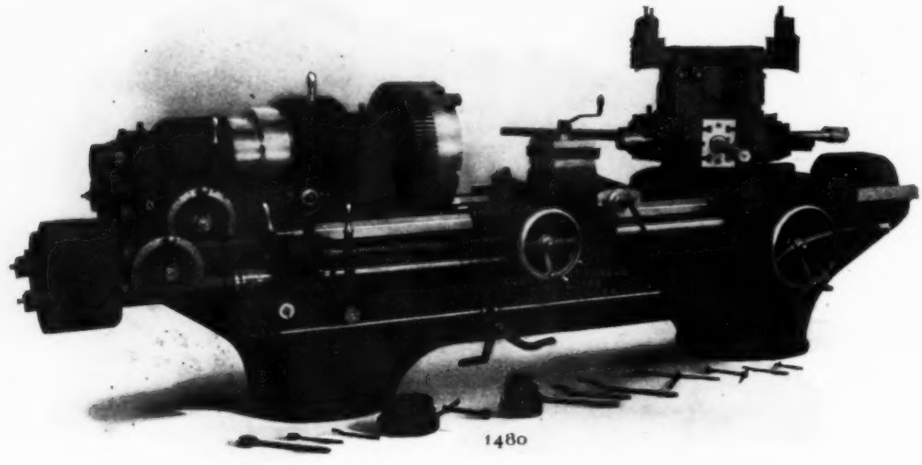

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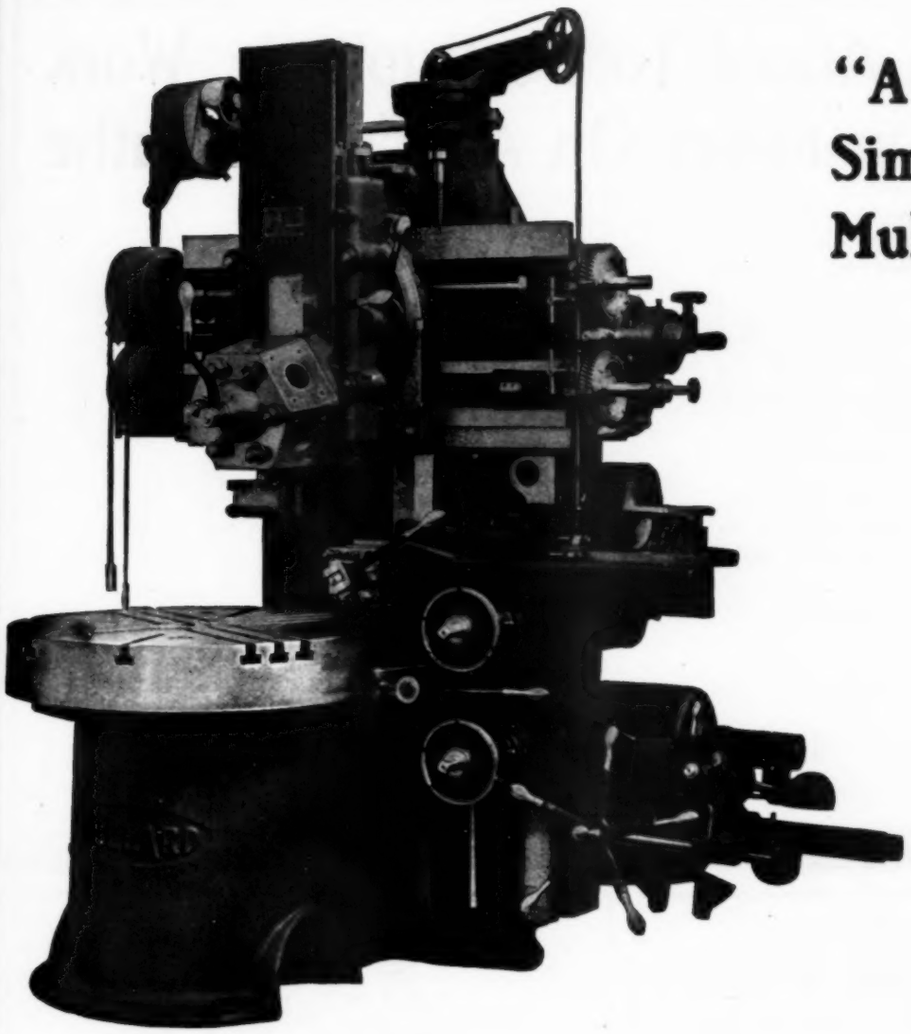

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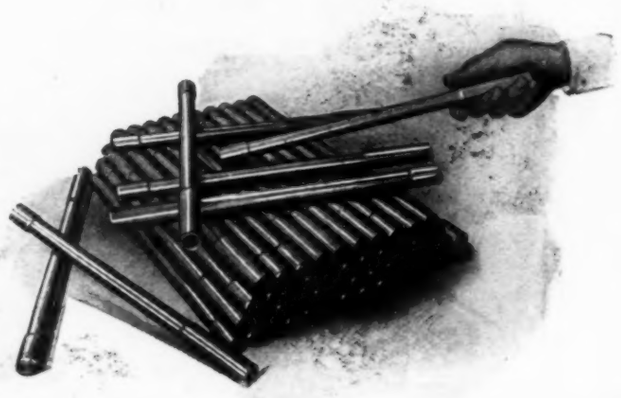

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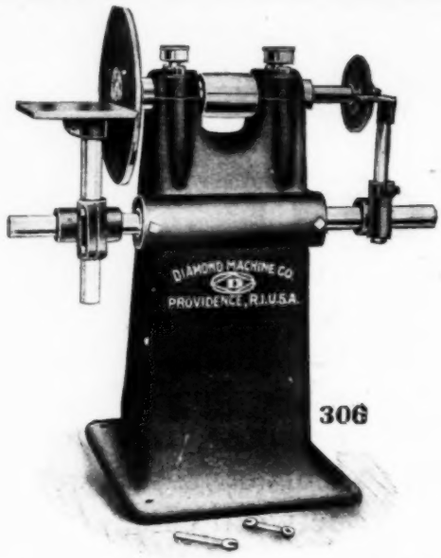

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Reversing Mechanisms for Machine Tools—I

Control of Reciprocating Members on Various Types of Machines by Means of Shifting Belts, Clutches and Other Devices

BY LUTHER D. BURLINGAME*

That much study has been given to the designing of reversing mechanisms is indicated by the great variety of ways already devised to accomplish an operation apparently so simple as reversing the travel of a slide or table. That there have been and still are varying conditions to meet and hidden difficulties to overcome is indicated by the efforts still being put forth to invent new reversing mechanisms. Such efforts may sometimes be due to a lack of knowledge of the present state of development of the art, so that a review and analysis of the subject may be of value in order to prevent some from going over old ground.

Peculiarities of Some Mechanisms

No doubt every one who has had to do with machinery has had experience with reversing mechanisms that did not reverse. Either the slide would come to a standstill when it should reverse or it would persistently keep going, passing the reversing point instead of reversing and not stopping until a wreck had been made of some part of the machine, and perhaps of the work and tool as well. Another trick of some reversing mechanisms is to go along satisfactorily until confidence is established in the mind of the workman, who risks running up to a shoulder or to the bottom of a hole, when, for no accountable reason, the reverse will decide to operate at a new point, usually not on the side of safety. Again, the reverse may decide to operate while the indexing is still in operation, resulting in the cutting of an unintentional spiral in the work, if nothing worse. These illustrations are suggestive of some of the many troubles to be encountered and overcome and it is often the case that a new machine has had the test of satisfactory running by the builder, to say nothing of having passed the eagle eye of the inspector, and it is not until it reaches the customer that it begins to play such tricks. The designer and draftsman are then confronted with the problem of working up another device to remedy the trouble; and at it they go, adding another variety of reversing mechanism to the many already existing, which, in turn, may give place later to the next inventor's idea. Washington Irving has said that philosophers are a class of men employed in tearing down the theories of those that have gone before them and building up a new set of theories for those that come after them to tear down. It sometimes seems as if succeeding generations of inventors and designers go through a similar round in their work.

Typical Devices

The devices here shown and described have been selected from a variety of sources and many of them are protected by patent. This article deals especially with such reversing mechanisms as are used on machine tools for controlling reciprocating parts, although many apply equally to the controlling of revolving parts. Outside of this field is a wide range of devices, including such reversing mechanisms as valve motions for engines and pumps, reversing mechanisms for printing and textile machinery, etc., a description of all of which would fill a volume. Then there are the elementary reverses that can hardly be said to require "mechanism" for their operation. Among these are devices that we have been familiar with from our boyhood days such as are found in the pages of "507 Mechanical Movements" and other classics of the mechanic's art. They include the cam and crank motions, the mangle motion and the external and internal mutilated gear where the advance, reverse and quick return are accomplished by having the driven pinion alternately engaging first the teeth of the internal gear and then the teeth of the smaller external gear.

The reversing mechanisms here shown are intended to be typical of the various conditions met in machine tools and illustrative of their characteristic features and the principles on which they operate.

General Classification

They will be treated according to the following classifications:

Case I. Reversing mechanisms with means for reversing without fail.

Case II. Without shock.

Case III. At an exact point.

Case IV. When employing a quick return.

Case V. When a slide to be reversed is in some inaccessible part of the machine.

Case VI. When the reversing mechanism is to be locked so that it is mechanically impossible for it to operate before the completion of previous operations.

Case VII. Means for passing the normal reversing point.

Case VIII. Means for automatically stopping when reaching the normal reversing point.

Case IX. Means for varying the speed or causing a dwell at the reversing points.

Case X. Means for controlling and operating the automatic reversing mechanism by hand.

Simple Mechanisms

Probably the simplest form of reversing mechanism is where the momentum of the moving parts is sufficient to throw over the reversing clutch, as in Fig. 1, or shift the reversing belts, as in Fig. 2. Fig. 1 represents a reversing mechanism employed to reverse the movement of a table. This table carries reversing dogs, which may be adjustable for length of travel. The table travels in a given direction until one of these dogs, pushing against the reversing lever, disengages the clutch teeth and, if there is sufficient momentum, continues to move until the clutch is thrown into engagement on the opposite side, thus reversing the direction of the table movement. This is shown simply to illustrate the principles underlying reversing mechanisms and not as a device suitable for actual use, for even if the momentum is sufficient to carry the clutch over, the teeth may catch on the corners of the teeth of the opposite clutch and having so slight a hold are liable to crowd or jar apart, due to the fact that the movement of the table and moving parts must be instantly arrested and started at full speed in the opposite direction when the clutch engages. Fig. 2 shows a simple form of reversing mechanism, that is practical when the momentum can be depended upon to do the reversing. This is a belt reverse, using open and crossed belts. A tight pulley *A* is located between two loose pulleys *B*, the face of each of the loose pulleys being twice the width of one of the belts. When the table dogs engage the reversing lever, it is rocked, operating the rod *C*, first shifting the driving belt from the tight pulley and then while this belt is carried still further along on the face of the loose pulley, the reverse belt is drawn on to the tight pulley, thus reversing the direction of travel.

Mechanisms Operating Without Fail

In many cases, however, momentum cannot be depended on and Fig. 3 shows a reversing mechanism which will operate independent of the momentum, thus illustrating Case I in providing mechanism for reversing without fail.

This is accomplished by using a pivoted weight *A*, which, when moved until it

*Chief draftsman, Brown & Sharpe Manufacturing Company.

passes the center of gravity, will fall with sufficient force against the arm *B*, to which the clutch fork *C* is fast, to withdraw the clutch and throw it into engagement on the opposite side, thus reversing the direction of the screw *F*.

Fig. 3 is also novel in that it shows the control of a vibratory slide swinging from a pivot *E*. The amount of travel is determined by the adjustment of the set screws *D*.

Another device to insure reversing makes use of a spring plunger, the spring performing the same office as the weight just described, to forcibly throw the clutch over independent of momentum. This is shown in Figs. 4, 5, 6, 16, 17 and 18, all of which, as well as Fig. 3, illustrate Case I as having means for reversing without fail.

Cushioned Reverse

Fig. 4 shows a reversing mechanism which is used on a fluid-operated machine and requires few and simple parts. One of the dogs *A* strikes the lever *B*, forcing it over until it has passed the high point of the spring plunger C, when the spring acts to complete the movement of the lever, taking up the remaining lost motion between the shoulders of the valve rod *D*, lost motion being required in order that the V on the lever may pass the point of the spring plunger before the valve is shifted. The valve is then forced over so as to reverse the fluid pressure operating the table. This method makes it possible to cushion the shock of reversing to any desired extent, illustrating Case II, where it is required to reverse without shock. All belt reverses also illustrate Case II, as the slip of the belt allows a degree of cushioning action. Most of the belt reverses shown are classified to illustrate other features. The one shown in Fig. 5, however, may be described in this connection. This is one of the simplest forms of a belt reverse

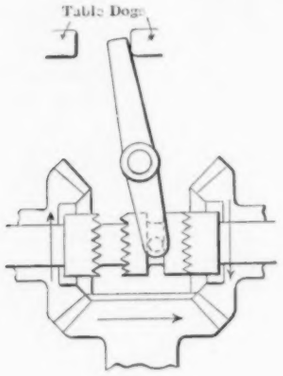

FIG. 1

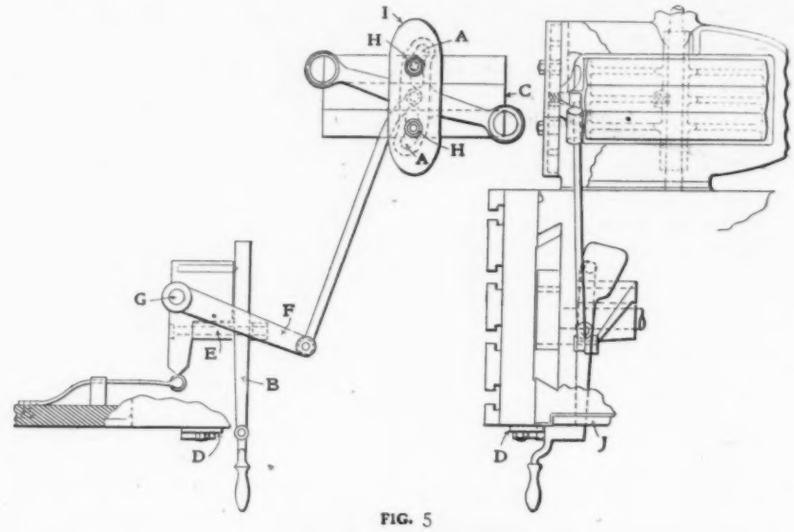

FIG. 5

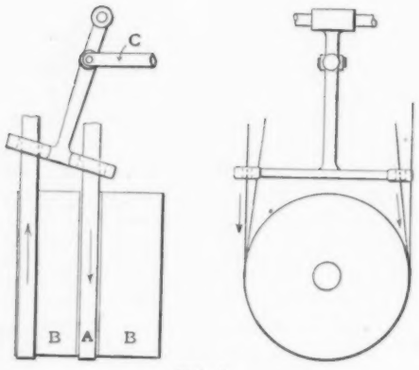

FIG. 2

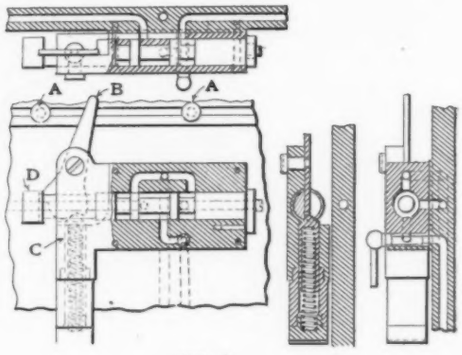

FIG. 4

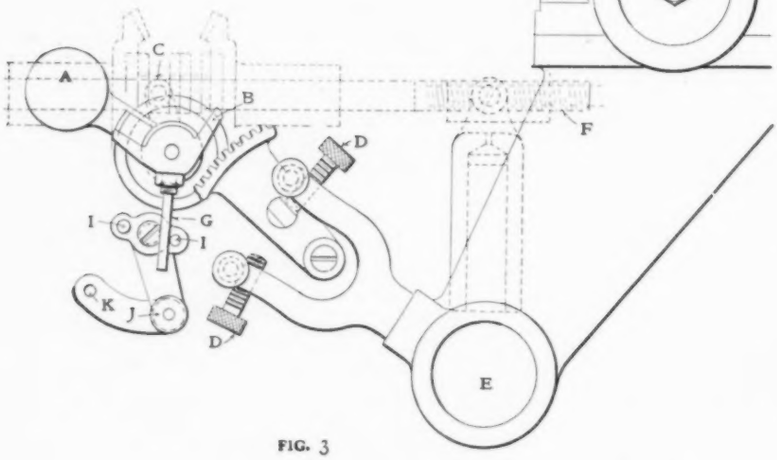

FIG. 3

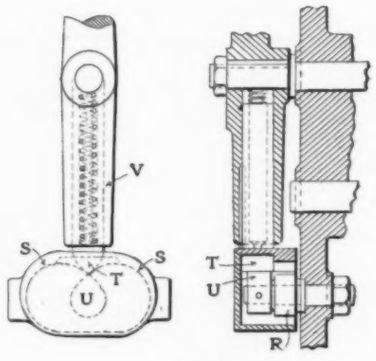

FIG. 6

REVERSING MECHANISMS

that meets the various requirements of practical work and was designed for reversing the table of a face grinding machine built by the Brown & Sharpe Manufacturing Company. The cam grooves *A* are so shaped that the first movement in reversing is to shift the belt from the tight pulley *C* by pivoting in one of the cam grooves. The studs *H* carrying rolls in the cam grooves are stationary and hold the cover *I* in position.

leys, thus bringing the table to a state of rest.

VIBRATING REVERSING PLUNGER

A method of avoiding shock when a spring plunger is used, and illustrating still further Case II, is to make the reversing plunger shaped as in Fig. 6 so that it can vibrate back and forth after reversing before coming to rest, by having the roll *R* ride on the curved seat *S*. The clutch teeth can be cut sufficiently

which the point of reversal is to be exact. Such a form of reversing lever has the disadvantage, that, when much pressure is required to do the reversing, the excessive friction in the sliding stem *V* of the plunger tends to produce a cramping action.

"LOAD AND FIRE" DEVICES

Fig. 7 shows a reversing mechanism designed especially for the purpose of re-

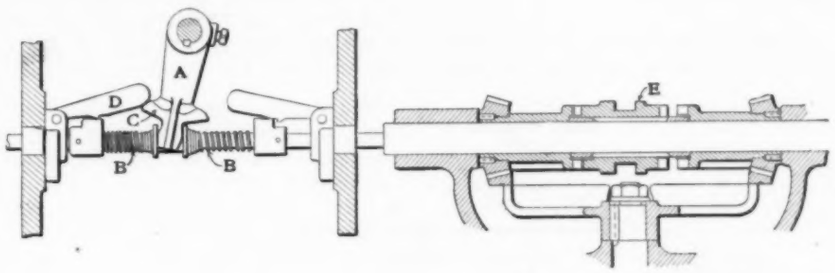

FIG. 7.

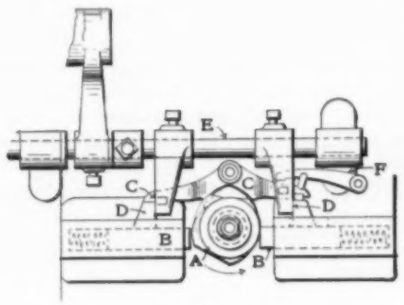

FIG. 8

"LOAD AND FIRE" DEVICES

After the belt has been thrown on to the loose pulley, the other cam groove by reason of its new location then becomes the pivot and the further motion of the lever carries the reverse belt on to the tight pulley. The lever *B* is pivoted at *E* in an extension of the lever *F*, which in turn is pivoted at *G*. The lever *B* can be depressed by hand so as to allow the table dogs *D* to pass. By depressing it still further it is held central by a notch *J* when both belts are on the loose pul-

deep so that the teeth will not bottom, thus further reducing the shock of reversing. In this construction the point of reversing is not as exact as is often required and to secure this advantage also, a modified form, shown in Fig. 6, can be used Where the two points *T*, *U*, located forward of the roll pass each other, the time of reversal is determined more exactly than when the roll alone passes the point of the plunger. This feature is an illustration of Case III, in

versing at exactly the same point each time and illustrates still further Case III. This was first applied to the Brown & Sharpe cylindrical grinding machines so as to make it possible to grind up to a shoulder within a few thousandths of an inch without danger of running by the reversing point and damaging the wheel and work. It operates on what is called the "load and fire" principle. The reversing lever, when actuated by one of the dogs on the table, rocks the lever *A*, com-

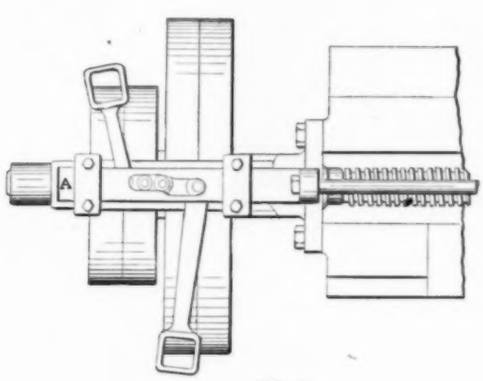

FIG. 9

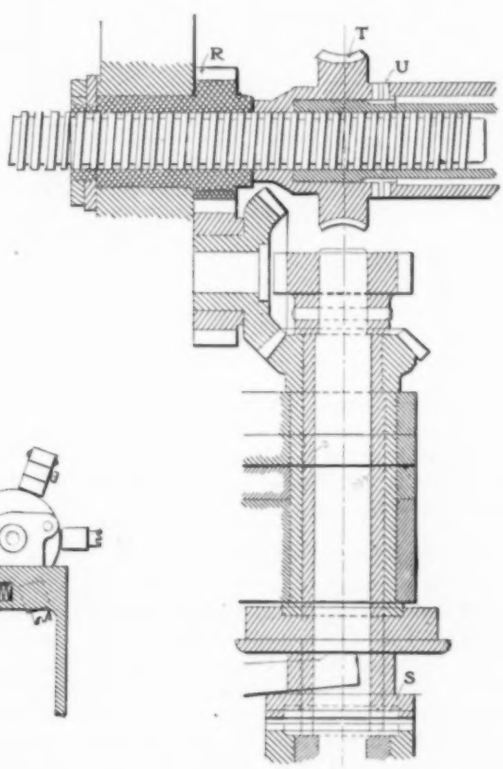

FIG. 10

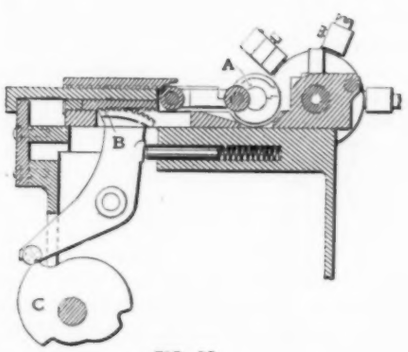

FIG. 11

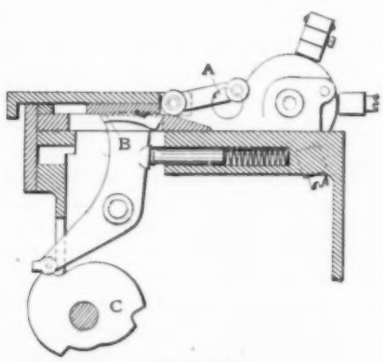

FIG. 11A

REVERSING AND QUICK RETURN DEVICES

pressing one of the springs *B*, until the wing *C* lifts the latch *D*, allowing the clutch *E* to be forcibly thrown into engagement on the opposite side. This mechanism for reversing can be modified so as to locate the springs either in the rocking levers or in the table dogs instead of as shown, if either of these modifications is better suited to the requirements.

Another construction of "load and fire" reverse is shown in Fig. 8, where the springs are compressed and the trips operated by cams on a revolving shaft. This form is specially adapted to a construction where the amount of travel is constant. The cam *A* revolving in the direction shown by the arrow forces back the plungers *B* alternately, and when the point of reversing is reached one of the wings *C* is lifted, also by the cam, unlatching it from *D* and allowing the spring to act, shipping the rod *E* which controls the clutches.

An added feature of this construction is shown in the latch *F*, which is a safety device to hold the clutch locked in place so that it is not possible for it to release until the wing *C* is lifted.

Planer Reverse and Quick Return

As illustrating Case IV, where the quick return is the special feature, we may refer to Fig. 9, which shows one of the many forms of planer reverse. Here the sliding bar *A* is controlled by the dogs on the planer platen. This bar has a cam slot in which rolls operate and through bell-crank shipper levers shift the belts and thus reverse the direction of travel. The cam groove is so formed as to shift the belt from the tight pulley before the belt on the loose pulley is shifted. With proper designing the planer platen with all its weight and momentum can be reversed quietly and at a comparatively uniform point. After shifting, the shipper levers are locked in position due to the shape of the cam slot, but the slide bar *A* is still free to move so that if the dogs overrun no harm is done. It is a common practice to make the dogs so that they can pass the lever, thus avoiding the possibility of the table being lifted by the dog when reversing.

Other Quick Return Applications

Case IV is also illustrated by an effective quick return suitable for use on the cutter slide of a gear-cutting machine and is shown in Fig. 10. It was designed for the Brown & Sharpe gear cutters as they were built a quarter of a century ago. A distinctive feature of this reverse is that it is accomplished by revolving the nut *R* at a higher speed than the screw is revolving and in the same direction, thus producing a differential motion, returning the slide quickly for a new cut without disengaging the mechanism driving the forward feed. At the completion of the quick-return movement of the slide, the clutch *S* is automatically disengaged and the nut *R* again locked in position, the slide responding to the constantly revolving screw and feeding the cutter forward, through gearing connecting to the worm wheel *T*, which through the clutch *U* is connected to the screw. The clutch *U* is disengaged to stop the automatic feed and to allow of the hand feed being used.

Figs. 11 and 11A show the quick return used on the turret slide of the Brown & Sharpe automatic screw machines, a feature of interest in this construction being that the quick return is accelerated by revolving the eccentric *A* at the time when the slide is to be returned, giving a rate and distance of travel equal to the combined movement of the rack *B* and the eccentric *A*. Fig. 11 shows the cam *C* just in position for the slide to be retracted. Fig. 11A shows the slide partly retracted and the turret brought to its next indexed position. Other of the illustrations, as, for example, the planers, also show reversing mechanisms where a quick return is employed and further illustrate Case IV.

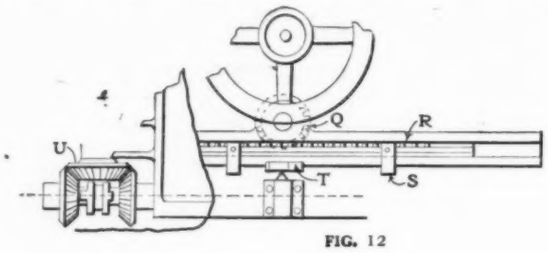

FIG. 12

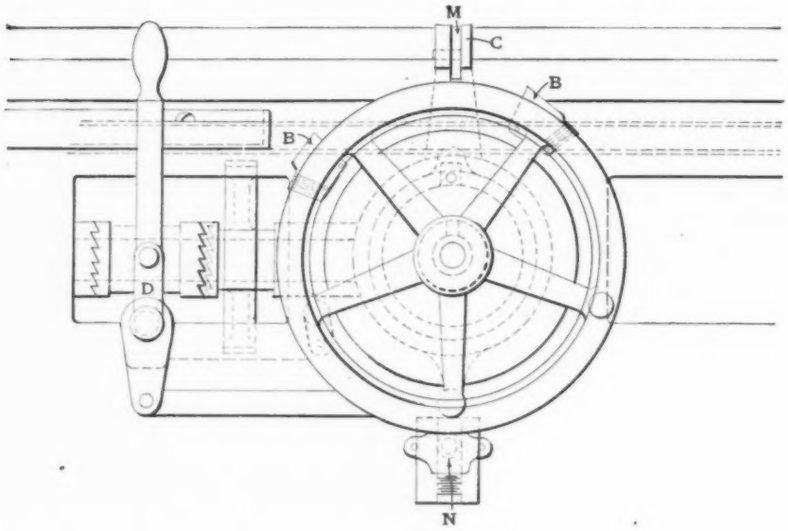

FIG. 13

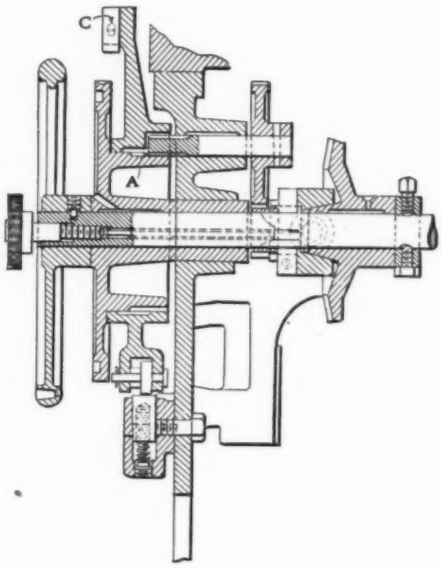

FIG. 13A
Section M-N, Fig. 13

GRINDING-MACHINE REVERSING MECHANISM

Controlling a Rear Slide from the Front of the Machine

Case V, in which it is necessary to control the reverse when the slide is in some inaccessible part of the machine, is illustrated in Figs. 12, 13, 14 and 15. The first three of these are designed for Landis grinding machines to reverse the traveling wheel carriage located at the back

of the machine from a stationary point at the front where it will be convenient for the operator. Fig. 12 shows a construction in which the motion of the wheel carriage is transmitted by a pinion *Q* to a sliding rack *R* at the front of the machine. The rack carries dogs *S* adjustable for any required travel. These dogs engage the lever *T* operating an ordinary bevel-gear reversing mechanism, as shown at *U*.

Figs. 13 and 13A show what may be considered as a circular rack *A* on which the adjustable dogs *B* are located. These dogs engage the lever *C*, which operates the clutch *D*.

The dog nuts *A* shown in Figs. 14 and 14A can be set in any required position by turning the adjusting pinions *B*, engaging teeth in their peripheries. The travel of the wheel slide revolves the screw *C*, moving the dog nuts *A* until one of them engages one of the lugs *D* and rocks the lever *E*, thus shifting the reversing clutch *F*.

A Gear-cutter Application

Fig. 15 shows the application of this principle to the reversing of the cutter slide of the automatic bevel-gear cutting machines built by the Brown & Sharpe Manufacturing Company. It will readily be seen how difficult it would be to make the necessary connections from dogs on the cutter slide *G* through the hinged and sliding joints to the reversing clutch in the feed case *H*. This is entirely avoided by the device shown. The pinion *A* revolves in time with the feeding of the slide *G* as both are driven from the same shaft *I* and shifts the bar *B* back and forth. The dogs *C* can be set for the required travel. It is possible with this invention to make the travel of the dogs greater or less than that of the slide if desired. For instance, if space is limited, the travel of these dogs could be less. If the distance to be traveled is to be very short and the point of reversing requires to be exact, the distance the dogs travel can be increased so as to be many times as great as the travel of the slide.

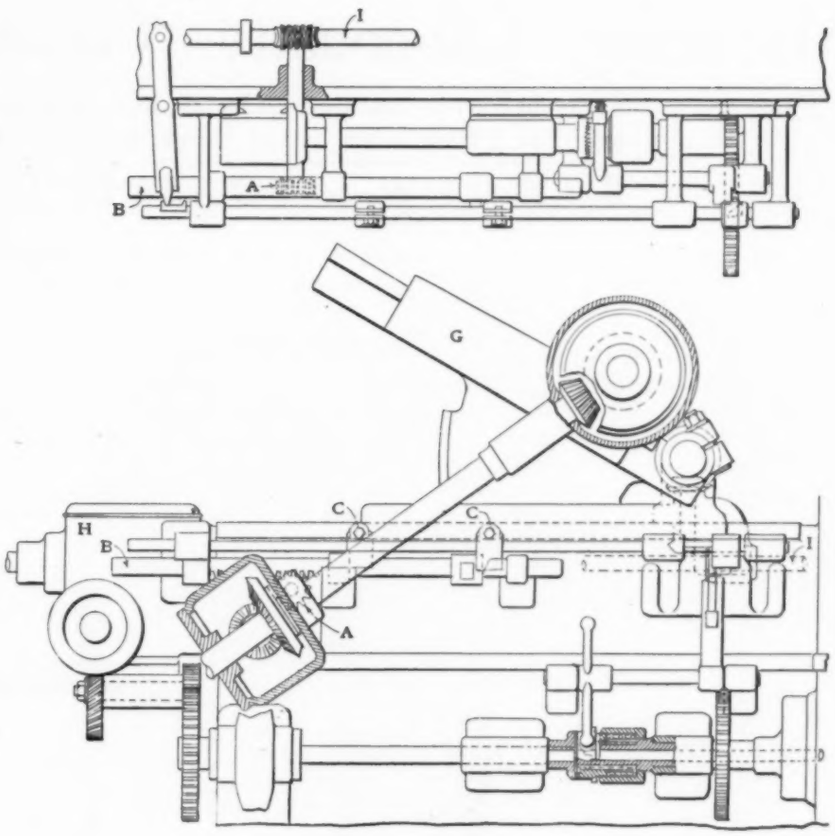

FIG. 15. REVERSE FOR BEVEL-GEAR CUTTER

Measurement of Wood Screws

The item in the January 16 issue relative to the measurement of wood screws brings forth the following expression from the Corbin Screw Corporation:

"Some of the manufacturers of wood screws some time ago realized the fact that measuring round-head wood screws over the head was not proper, as it gave so many different lengths of screws under the head, i.e., the heads on the small diameter screws are so much thinner than the larger diameters, it makes the small screws longer under the head than larger diameter screws.

Some time ago we adopted a standard of measurement under the head, making all screws alike, and making them 1/16 inch shorter under the head than the length called for, i.e., a 1½-10 round-head screw would measure 1 7/16 under the head, and so would all other sizes of the same length."

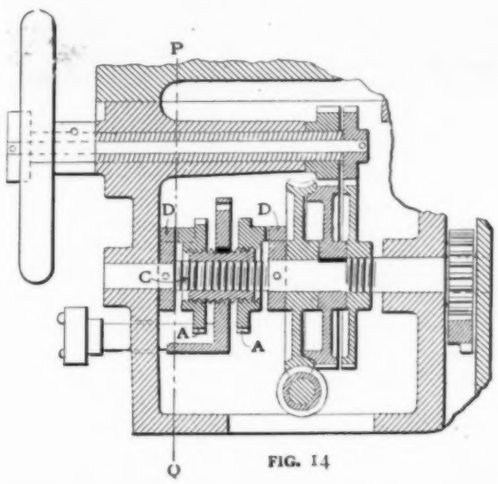

FIG. 14

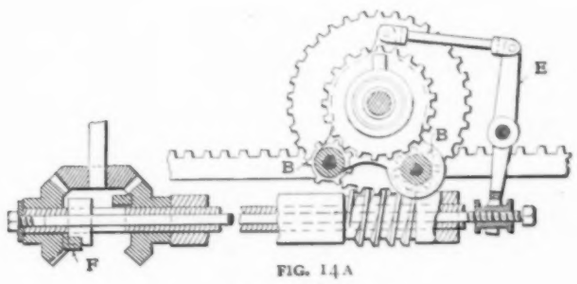

FIG. 14A

Section P-Q Fig. 14

GRINDING-MACHINE REVERSING MECHANISM

Machining Oil-country Gas-engine Cylinders

Different Turning and Boring Operations, with Special Jigs, Machines and Boring Bars Used by the Joseph Reid Gas Engine Company

BY W. OSBORNE

The accompanying photographs show a somewhat unusual design of a gas-engine cylinder and help to explain how it is bored.

The casting, as shown in Fig. 1, is in reality two cylinders cast in one piece. The back ends of both are cast closed, as can be clearly seen in Fig. 2, being pierced only by small cores which serve to steady the barrel cores, but are not of any use in boring. The long cylinder is the work cylinder. It is water-jacketed from the flange, the water jacket extending back around the explosion chamber and over to the other cylinder so as to surround the valve which separates the two cylinders.

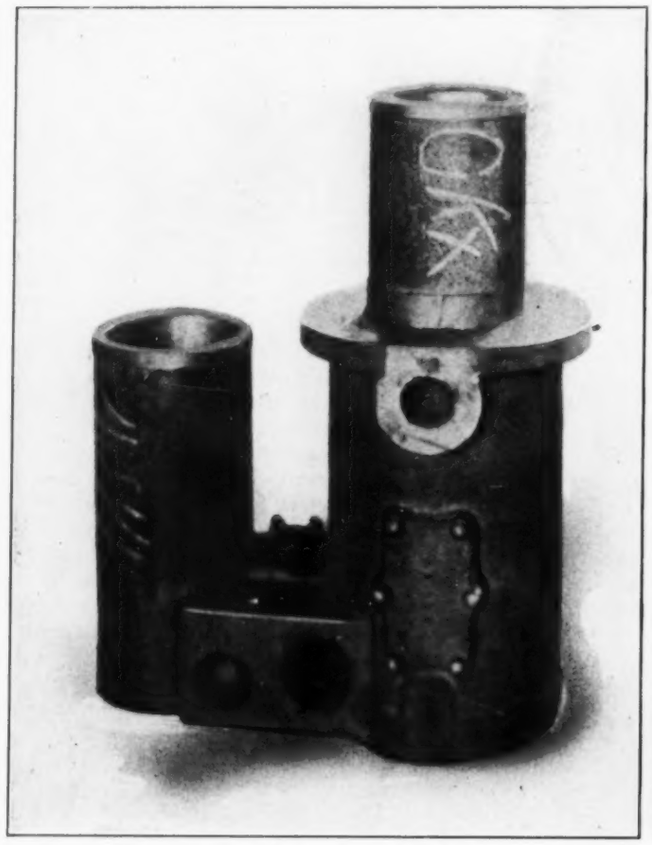

FIG. 1. CYLINDER CASTING AFTER MACHINING

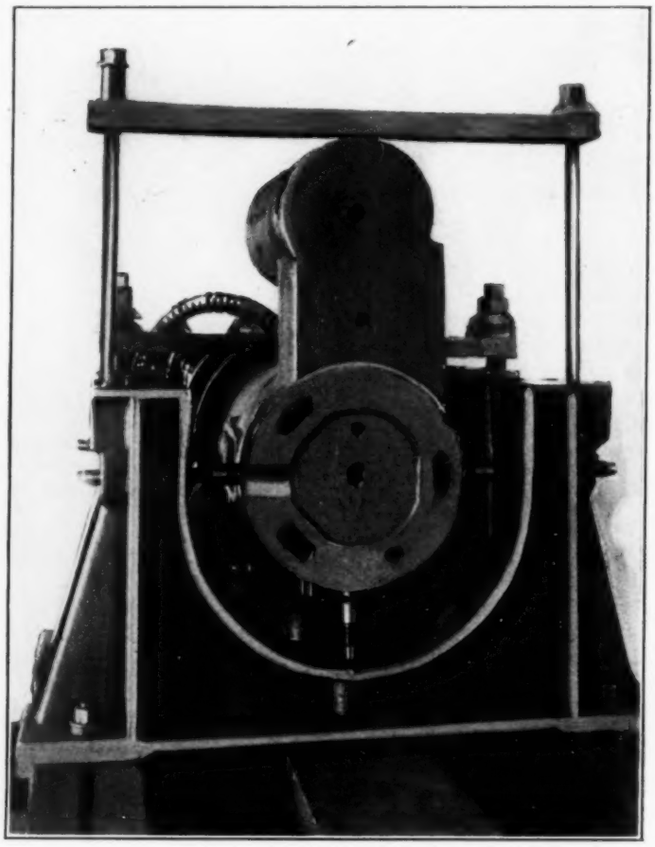

FIG. 2. CYLINDER SET IN BORING MILL TO TURN OUTSIDE

After the water jacket has been closed and tested under heavy water pressure and found to be all right, the flange is faced and turned, and the part of the cylinder that fits into the bed is turned. It is set up for turning as shown by Fig. 2. In setting for this work the cylinder is first set true by the outside; then this setting is checked by testing the inside. From the methods used in the foundry in making the molds, when the outside is true the inside should also be; this is in a sense inspecting the molder's work.

The turning and facing are done to gage, so that the cylinders will interchange. This work is done on one of the boring mills which the company built to solve the problem of boring two accurate holes parallel with one another.

As the cylinders have one end closed, it is necessary to bore them with an overhanging bar. The spindle to which the boring bar is attached is made of cast iron six inches in diameter and has long bearings also of cast iron. The fixture that holds the cylinder while it is being bored is made to slide sideways, so that it is not possible to bore the cylinders out of line. Figs. 3 and 4 show the general arrangement of this special boring mill.

In designing the fixtures and in planning the work it was kept in mind that it is very easy to spring cast iron. The cylinder fits in the fixture the same as in the bed where it is finally used, and it is held by being clamped by the flange. After being clamped here, the screws are run up so as to steady the back end. In boring, the side cylinder is first roughed out. Then the fixture is moved over, the centering pin dropped into place, and the main cylinder roughed and finished. After it is finished, the fixture is moved back to the starting place and the side cylinder finished. By boring the main cylinder before the side cylinder is finished, any distortion caused by removing the stock from the main cylinder does not affect the alinement of the two cylinders with one another.

The cutter heads are made to screw into the end of the boring bar. Various forms of heads have been tried, but the heads with two cutters, one on each side, have been found to give the best satisfaction. As the bore of the side cylinder has to run up until it touches the closed end, it is necessary to make the cutters overhang the end of the cutter head. A small grinding attachment has been made which

grinds the finishing cutters in their head and puts on the proper clearance at the same time. It is essential that the finishing cutters be exactly the same distance from the center and cut alike.

Fig. 5 shows one of the finishing-cutter heads. In the roughing heads the cutters are held in place with set-screws, but those in the finishing heads are held in place with clamps. The inner end of these cutters rests on a center bolt which has a tapering end, so that by drawing this bolt in the cutters are expanded.

Fig. 6 shows a bed ready to be faced and bored to receive a cylinder. It is done on the same machine that is used to face the cylinders, as shown in Fig. 2. The same holding pieces are used on the front and back ends in facing the cylinders, and the same pieces will handle all sizes. In facing the beds a different fixture is used on the back end of the machine, but the same one in front.

A view of the fixture that is used in holding the cylinders while they are being bored will show that it is massive. This is clearly seen in Fig. 4. The first of these cylinders was bored on a lathe. The fixtures were made as heavy as could be handled on this lathe, which was the largest one in the shop; but they were not heavy enough, neither was the lathe heavy or rigid enough. The regular boring mills on the market did not allow of handling

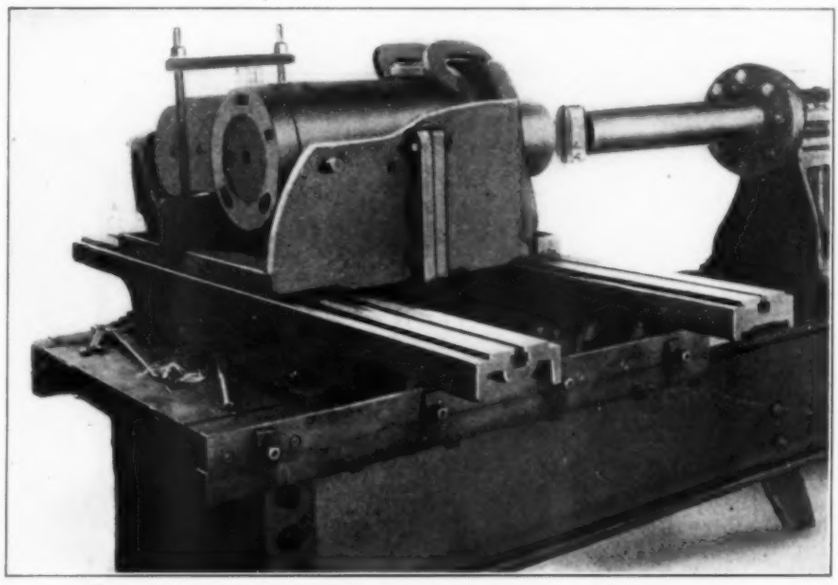

FIG. 4. BORING MILL, JIG AND BORING BAR FROM BACK

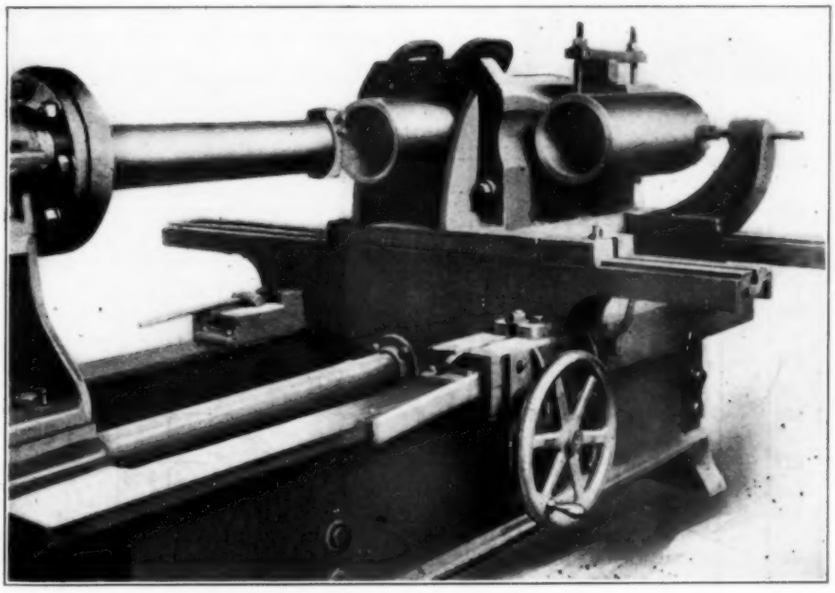

FIG. 3. SPECIAL BORING MILL, JIG AND BORING BAR

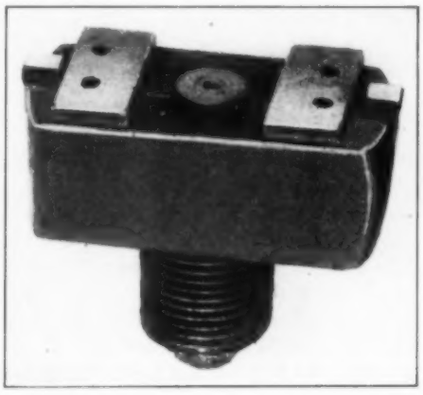

FIG. 5. CUTTER HEAD ON BORING BAR

such a design of cylinder, so a mill was designed and built. The mill itself was made very heavy, as were the fixtures. It has been necessary to make several of these mills up to date, and the latest ones have been still further strengthened and stiffened. Some of the fixtures which were thought to be extra heavy when made have been discarded and others of nearly twice the weight made to replace them.

As an illustration of the kind of work which this machine does in the way of accurate boring, three cylinders were tested with an inside micrometer. These cylinders were on the floor, had been bored for several days and were selected at random. In none of these cylinders was a variation found of one-thousandth of an inch either in round or straight.

The effort is not made to have them as close as that to the nominal size, as the expense would not serve any useful purpose. They may vary in that way several thousandths either over or under, but each one is made round and straight. At one time it was thought that there would be a gain in workmanship if these cylinders were ground, and a machine was made for doing it. The principal advantage which it was thought would be obtained by grinding was the saving of time in wearing them in on the testing block. Experience has shown that where a cylinder is bored round it will come up better and quicker when not ground. While the piston rings which go into these cylinders are all turned to the size of the cylinder, after being cut apart they have to be sprung over the head in placing them in the grooves; with the most careful handling this distorts them some. This must be worn off, and a smooth-bored cylinder still has grip enough on them to do it even in the presence of proper lubrication. With a cylinder polished to a dead-smooth surface before being put on, the rings have nothing to grip on and come to a good bearing very slowly. One without experience might think the difference would not be a noticeable one, but it is.

When it is known that these gas engines have been run for over 11 years without having the cylinder rebored or the piston rings renewed and are still in good shape, it will be understood that under favorable conditions the wear must be exceedingly slow.

In re-turning the piston rings, it has

been found best to use a fine feed but not to make a dead-smooth finish.

While these cylinders are bored with reasonable accuracy, they are not bored in any record-breaking time. In boring the side cylinder three cuts are run through it, and four cuts are run through the main one. This gives over 15 feet of boring on the size of cylinder shown.

If an attempt is made to run the finishing cutter through at a rate of speed as high as the steel will stand, the cylinder will be tapered, getting larger as the boring proceeds. Experience has shown a speed above which it is not best to go, and the harder the cylinder the slower the speed or the worse the taper.

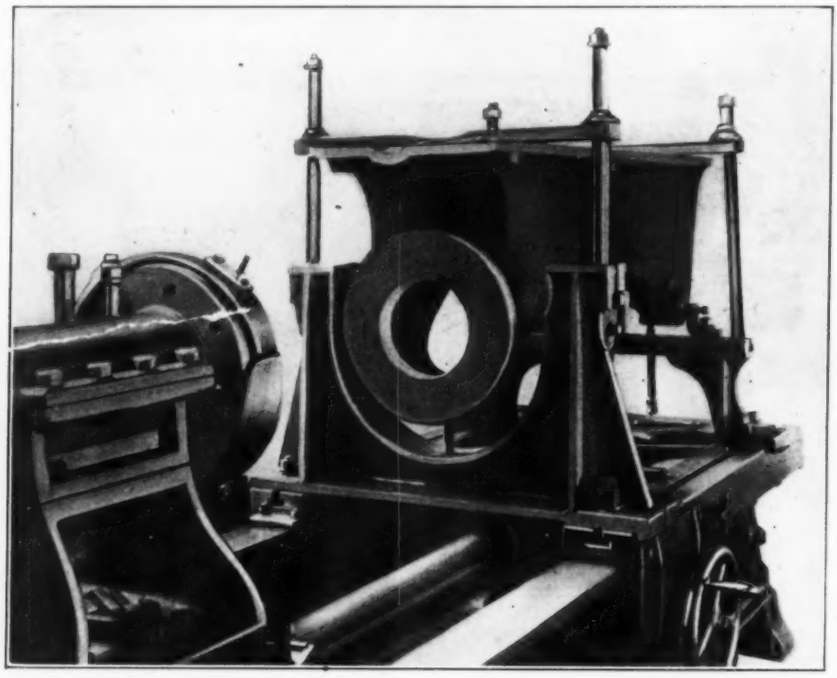

FIG. 6. TURNING FLANGE AND BORING THE BED

These cylinders are used on the Reid gas engines. The engines are made by the Joseph Reid Gas Engine Company, of Oil City, Penn., and are well known wherever oil is produced.

According to a German publication a firm in Munich has succeeded in artificially rendering asbestos waterproof and has put upon the market this kind of asbestos under the title of asbestos slates. These asbestos slates, it is claimed, are as hard and as strong as the natural slates and can therefore be laid on wall or roof constructions without any wooden laths being necessary. They are very easily worked, and can be bored, nailed and cut just like wood, without any danger of splitting. They are valuable for insulation work of all kinds, forming a fireproof covering for inside and outside walls, and will find ready use in many ways where fire, water, heat, cold, dampness, etc., are to be found.

Friction of Cams

By Con. T. Wise

I have lately designed a machine requiring several cams. Some of my work would probably not be accepted as scientific, but it seemed to "get there," which was all that was necessary, with the exception of one cam which we had to help over one part of its path with springs. All these cams were what I call radial cams, that is, the cam rod moved back and forth in line with a radius through the center of the shaft on which the cam turned. The cam rods were forked and were guided at one end by the shaft and at the other end by a freely sliding bearing.

Now that the job is all done and paid for, it has occurred to me that it might be interesting to know what the relations should be between the angle which the working face of the cam makes with the direction in which the cam rod works, the coefficient of friction and the weight which is to be lifted by the application of a given turning moment to the cam. I have a friend in one of the technical schools whom I often go to in such cases, so I laid the matter before him with a result which I will tell in my own way.

Equation of Forces Acting on a Cam

First he showed me a sketch of a cam, the cam rod and its pin or roll with a lot of arrows on it to show the forces acting on them. I will reproduce it later as it is rather too blind for most of us to bother with. From this he arrived at this formula:

$$W = \text{the load lifted} = \frac{P\{\sin.\theta(1 - f f_1) - \cos.\theta(f + f_1)\}}{\sin.\theta + f\cos.\theta},$$

Where P is the pressure tending to move the cam at its point of contact with the cam roll, θ is the angle of the working face with a radius through the point of contact, f is the coefficient of friction on the cam roll and f_1 is the coefficient of friction between the guides and the cam rod. If f is the same as f_1 then this becomes:

$$W = \frac{P(\sin.\theta - 2 f\cos.\theta - f^2\sin.\theta)}{\sin.\theta + f\cos.\theta},$$

From this it will be noticed that if the expression to the right of P, that is

$$\sin.\theta - 2 f\cos.\theta - f^2\sin.\theta,$$

becomes equal to zero either by change of θ or f, then W is zero. Thus no weight can be lifted no matter how great a force may be applied. There is, therefore, for every angle θ a corresponding maximum value of f at which it becomes impossible to turn the cam. He has figured a number of these values and plotted them in Fig. 1, showing the greatest values of f for different angles θ. This was carried up to only 75 degrees with the radius, because for greater angles there is never

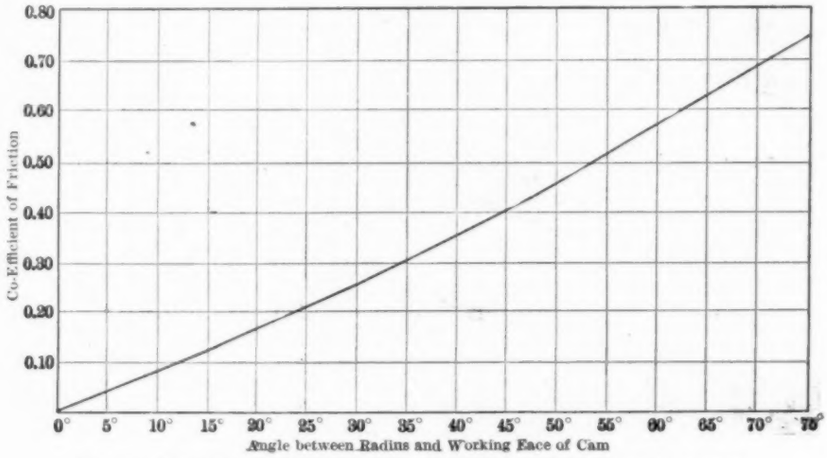

FIG. 1. COEFFICIENT OF FRICTION FO VARIOUS ANGLES OF CAM ACTION

any trouble with the working of cams. This is not to be wondered at when the 75-degree angle has a coefficient of friction of 0.75. On the other hand this curve tends to show that at θ angle, or when the outline of the cam is along a radius, a coefficient of friction of zero is also necessary, which we can readily believe.

It must be borne in mind that the angle θ is the angle of the working face of the cam with the line of action of the cam rod, and that it may easily be different from the angle of the cam rod with the path which the cam roll is passing through at that moment. Fig. 2 illustrates this. The path of the center of the cam roll is shown by line $A\,B$ at θ degrees with the radius of the cam through the center of the roll. The inside of the cam groove $C\,D$ is very evidently at a more acute angle α with the radius through the point of contact with the roll at E. It should also be borne in mind that cam rolls are not very apt to run under conditions which would not be tolerated in any other bearing. More often than not no provision is made for oiling the pin on which the cam roll turns; even if provision is made, oiling is often entirely overlooked. For a roll running on a pin of one-half its diameter and in a cast groove, the coefficient of friction might easily reach 0.5 and the friction of the guides may reach as much, especially if they are arranged so as to cramp the rod. The usual custom of limiting this angle to 45 degrees would indicate that experience has shown 0.4 to be the highest coefficient of friction that need be provided for.

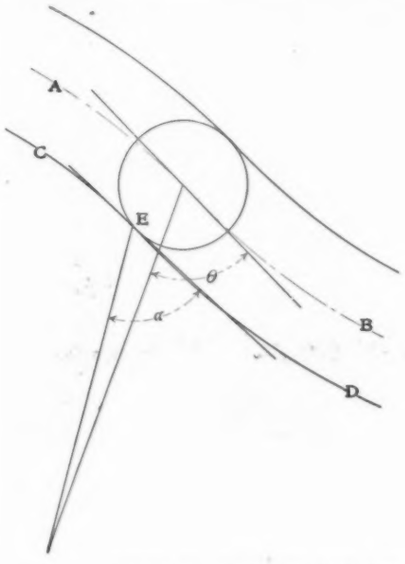

FIG. 2. ANGLES OF ACTION OF CAM ROD AND CAM ROLL

For the sake of showing more clearly the benefits of good design and workmanship, I have had my college friend draw the curves of Fig. 3, giving the relation between the pressure applied W and the resulting lifting pressure on the cam roll for coefficients of friction of 0.05, 0.1, 0.2, 0.3 and 0.4, and for varying angles of the working face of the cam with the radius up to 75 degrees.

Development of the Equation

Since some will have a curiosity to know how my technical friend arrived at this long, weird-looking equation, and some may wish to criticize it, I have added Fig. 4. Here O represents a stationary cam roll sliding on the surface of a cam whose working face is $A\,B$, center at C and being guided in a vertical line $D\,E$ by a guide which I have here drawn as opposite the roll. This guide is usually divided and part placed above and part below the cam roll, but this arrangement has the same effect in a mechanical way. The pressure P is supposed to be applied at the point G where the cam roll comes in contact with the cam and is perpendicular to the radius $C\,G$. The load lifted is W; $N\,N$ are the reactions between the roll and the guide; $f\,N$ and $f\,N$ the friction between the two surfaces; $N'\,N'$ the reactions between the roll and the cam, and $f'\,N'$, $f'\,N'$ the corresponding friction. The reactions between the cam and its shaft is $Q\,Q$. The angle which the face of the cam makes with the direction in which the load is lifted is θ.

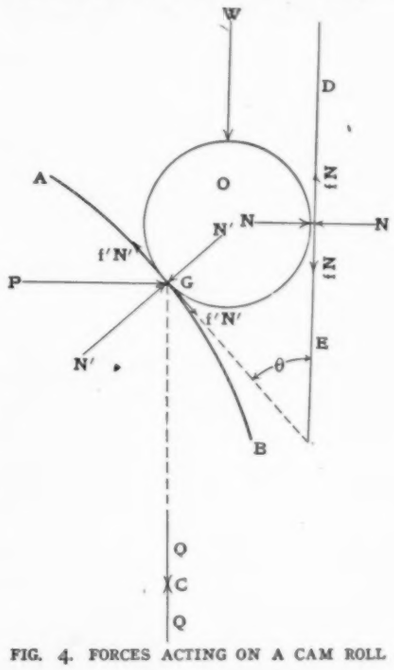

FIG. 4. FORCES ACTING ON A CAM ROLL

Considering the horizontal components only of the forces acting on the cam itself, we have:

$$P = N' \cos.\theta + f' N' \sin.\theta.$$

From which

$$N' = \frac{P}{\cos.\theta + f' \sin.\theta}.$$

Considering only vertical components of the forces acting on the cam roll, we get:

$$W = N' \sin.\theta - f' N' \cos.\theta - f N.$$

Putting the value of N' in the above, we get:

$$W = \frac{P(\sin.\theta - f' \cos.\theta - f\cos.\theta - f f' \sin.\theta)}{\cos.\theta + f \sin.\theta}.$$

The number of locomotives ordered from Russian works in 1906 was 873, according to *Engineering*, of which 812 were for the Russian State Railways and 61 for private railways. Of the 729 locomotives ordered last year, 637 were for the Russian State Railways, 88 for private Russian railway companies, and four for private individuals. The orders for locomotives thus far given out in Russia for delivery in 1908 comprise 558 engines. Of these, 283 are goods engines of a heavy type, and 219 passenger engines. It is, of course, probable that further orders may be given out for delivery in 1908 before the year has run its course.

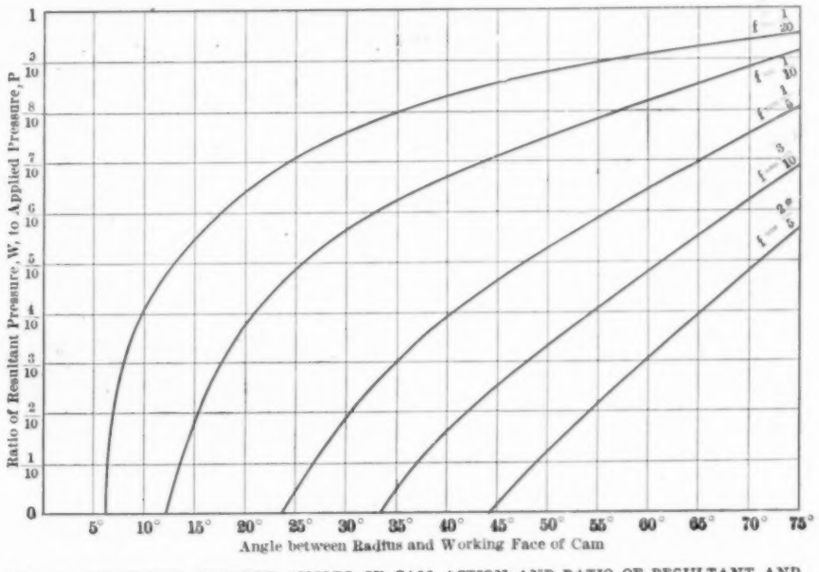

FIG. 3. RELATIONS BETWEEN ANGLES OF CAM ACTION AND RATIO OF RESULTANT AND APPLIED PRESSURES FOR VARIOUS COEFFICIENTS OF FRICTION

An Uncommon Type of Pattern-Shop

A Variation of the Saw-tooth Roof—Quick Replacement of a Burned Building—Useful Devices for Pattern Shop and Drawing Room

BY H. J. KENNEDY

The pattern shop illustrated in this article, which is of quite unusual type, was designed and built in eight weeks to replace a two-story building which occupied the same site at the works of the Maryland Steel Company, at Sparrow's Point, Maryland, and which was suddenly destroyed by fire. To appreciate what that destruction meant, one should understand that the patterns for repair parts to the large blast furnace, bessemer and rolling-mill plant, the patterns which had been made for the marine department since its establishment, and numerous patterns for outside orders, covering machinery and engineering constructions of great variety, thousands of patterns representing 20 years of accumulation, were nearly all of them stored on the first floor of that building; on the second floor the pattern shop had been located, as well as the drawing room, designated "No. 1," where the draftsmen and most of the engineers of all except the marine and dock-building work had their quarters. The company had then on hand, besides other important orders, a contract to build four large ferry boats for the city of New York, most of the patterns for which had yet to be made; besides the necessity for filling these orders, there were the furnaces and mill to be kept running and supplied with repair parts, so it is evident that the burned building must be quickly replaced. And it was.

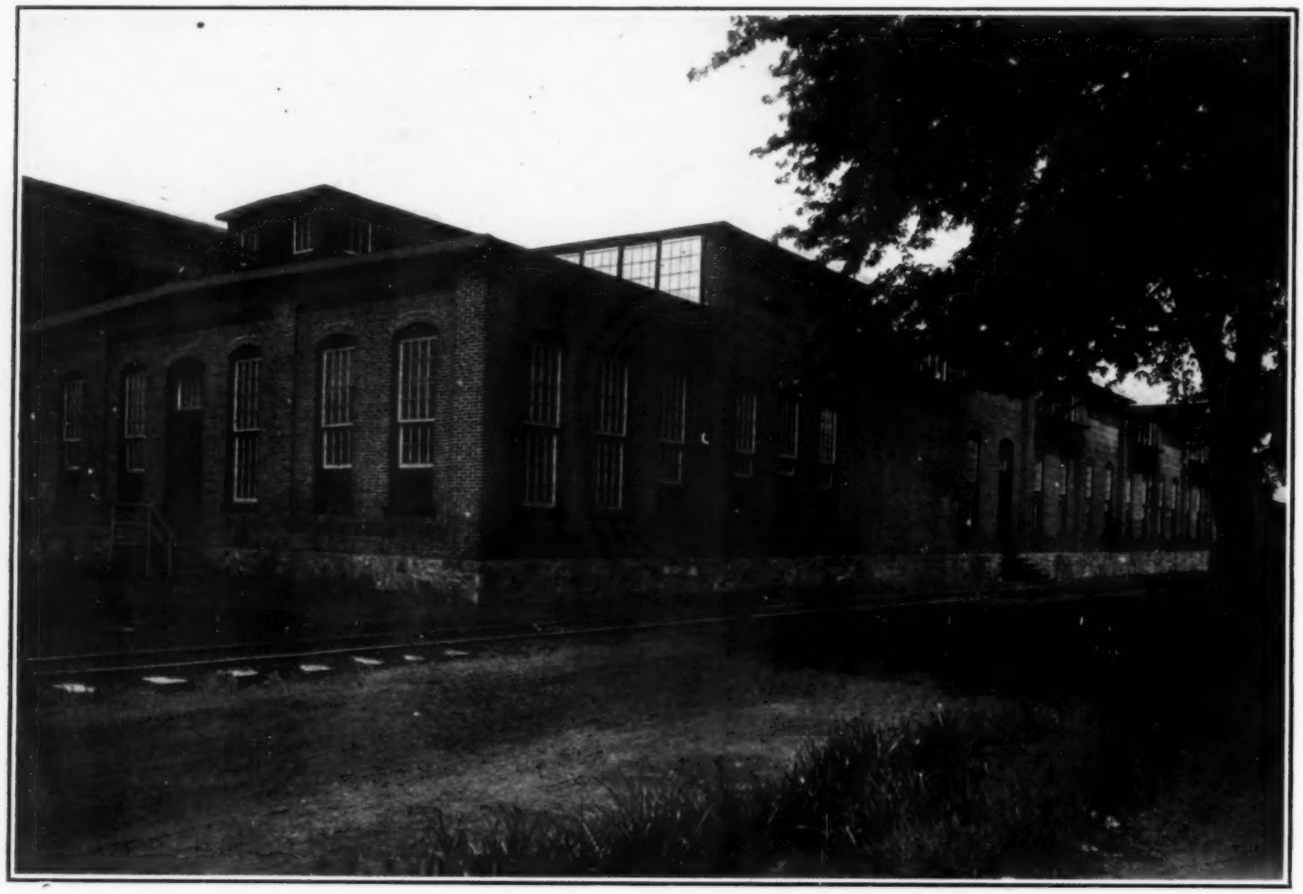

FIG. 1. SOUTHEAST CORNER OF PATTERN-SHOP AND DRAWING-ROOM BUILDING

In eight weeks, less two days, a new and improved pattern-shop and drafting-room building had been designed and erected on the site of the burned building, and occupied for its designed purposes. This building was entirely different from the old one, and its peculiarities will be described a little later.

The Remains of the Old Building

The new building was constructed partly on the old foundations, which were repaired and modified; the south wall of the old building, which was the only one that remained standing, was utilized as a partition between the pattern shop and the new drafting room, the latter being built on the ground floor as an extension of about 48 feet south of the old site. An extension was also made at the north end, giving the new building a total length of 309 feet 4 inches out to out of foundations, or 306 feet 3 inches inside of end walls, with an inside width of 59 feet 6 inches, as shown on the plan, Fig. 2. The hight is 16 feet 11 inches from the under side of the roof truss down to the floor, which latter is 2 feet 4 inches above the ground level. At the southeast corner of the old building stood a vault one story high, in which fortunately had been stored the thousands of tracings pertaining to the plant and outside mechanical orders; these were accordingly saved and the vault remains in use, now being directly accessible from the drawing room.

The New Roof

The most prominent feature of the new building is the roof, which is a design gotten up by Henry Aiken, a consulting engineer, of Pittsburg. Immediately after the fire Mr. Aiken was given the opportunity to apply his form of roof, coming to the scene and fixing its proportions; the Pennsylvania Steel Company, of Steelton, rushed out the trusses, which were soon ready to be placed on the 12-inch I-beam columns. It is claimed for this roof that it combines economy in construction with good lighting and ventilation, also ease of access to the window sashes.

The general form of the roof is apparent from the longitudinal section of the building, Fig. 4, and is shown in more detail in Fig. 5. In general outline it may be likened to a series of monitors running across the building instead of lengthwise of it. From the illustrations it can be seen that the building is spanned every 24 feet by vertical trusses, having parallel upper and lower chords, but distant 1rom the floor 1 foot higher in the center than at the walls. The general form of the truss is indicated in Fig. 3. Spanning every second bay between these trusses at the level of the lower chords are run purlins made of 10-inch channels, as clearly shown in Figs. 3 and 5, each of which carries a 3x4-inch nailing strip on its back; across these runs the 2-inch roof sheathing, covered by tar and slag roofing.

The alternate bays are covered by a roof at the level of the upper chords of the trusses, the purlins in this case being angle irons, riveted back to back in virtually a Z-bar form, and re-inforced by angle-iron bracings, as shown in Fig. 4.

Both upper- and lower-level roofs are, of course, horizontal in the direction of the length of the building, and pitched transversely each way from the center line of the building. The sheathing at the lower level comes right up to the truss, while that at the upper level projects 21½ inches beyond the central plane of the truss. Immediately below the outer edge of the high-level sheathing are placed the sashes, which are 5 feet 5½ inches high, and 3 feet 9½ inches wide, center to center of stiles. The sashes are alternately inner and outer, the inside sashes being capable of sliding and the outer ones being fixed. The overhanging of the high-level part of the roof gives a better protection for the interior, and also affords a narrow passageway (about 1 foot wide) between the roof truss and the adjacent sash, making it easy to clean the windows or replace broken panes, as well as to open or close the sashes from the inside if desired.

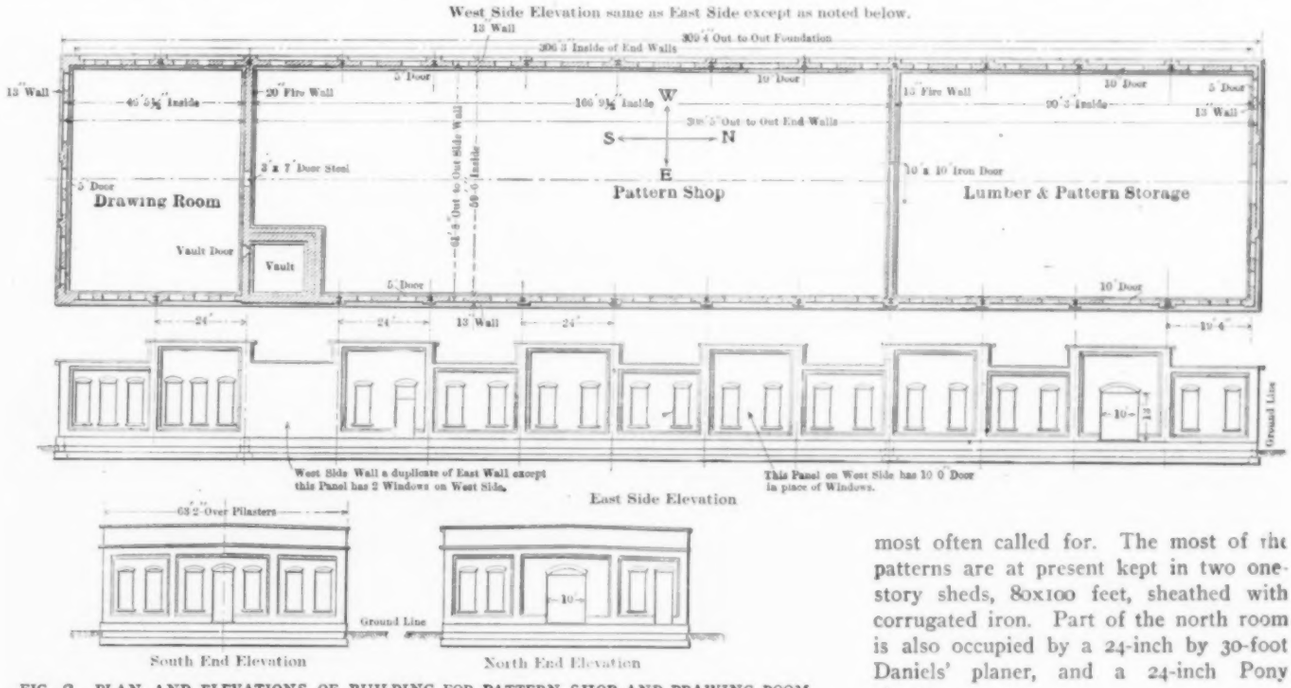

FIG. 2. PLAN AND ELEVATIONS OF BUILDING FOR PATTERN SHOP AND DRAWING ROOM

The Natural Illumination

As can be seen in the pictures, the shop is amply provided with windows on both sides, in addition to these roof lights. It is true that, during a part of the day, there are bands of direct sunlight across the shop, due to the rays entering through those lights with a southern exposure, but these are not found to be of any consequence in the pattern shop; if they were, ribbed glass could be used as a corrective. In the drawing room the glass through which sunlight would otherwise pass to the drawing tables has been covered with white paint, so the draftsmen are not troubled in this respect.

The Floor

The pattern-shop floor is very substantial. In erecting the new building, the site was filled in for a depth of about 4 feet with blast-furnace slag, a "waste material" which is very abundant and fortunately finds many uses at Sparrow's Point; above this is 8 inches of concrete, with 12-inch joists bedded in sand in its upper surface; upon this 1-inch Virginia pine is run diagonally, and finally comes the 1⅛-inch maple flooring running lengthwise of the building.

The Divisions of the Building—The Storage Room

The building is divided into three parts by brick fire walls with protected iron and steel doors, the northern part, about 90 feet long, being occupied for lumber storage, with a series of racks for some of the standard plant patterns which are most often called for. The most of the patterns are at present kept in two one-story sheds, 80x100 feet, sheathed with corrugated iron. Part of the north room is also occupied by a 24-inch by 30-foot Daniels' planer, and a 24-inch Pony planer.

The Pattern Shop

The middle portion of the building, which is the largest, nearly 167 feet long, is the pattern shop, and is shown in the interior view, Fig. 6. All the machinery is driven through shafting by a 50 horsepower electric motor, furnished with direct current at 220 volts and running at 600 revolutions per minute, mounted on a wall bracket at the side of the building. The main line of shafting, which runs at 250 revolutions, is 3 3/16 inches diameter and extends along the middle of the shop, being supported by hangers every 12 feet, which are fastened to two stringers, 8x12 inches, as shown in Fig. 7. These stringers are bolted to the lower chords of the roof trusses, and are reinforced between the trusses by two ⅞-inch truss rods.

Fig. 8 shows the method of supporting the work benches; it will be seen that they are carried by cast-iron brackets

(spaced alternately 4 feet 11 inches and 5 feet 7 inches) bolted to the wall by two ¾-inch U-bolts, which encircle 2½x½-inch bars set vertically in the brick wall. The benches are equipped with Emmert universal vises.

Heating of the Shop

In the north end of the building is located the Buffalo Forge Company engine, blower and heater which supply warm air for these two rooms. In winter steam at about 5 pounds pressure is used in the heater coils, the exhaust from the engine being turned in also. The aim is to keep the two rooms at 68 degrees Fahrenheit, and no difficulty is experienced in doing so. The intention was to carry the heater pipe from the blower along the shop with outlets at intervals; but it was found sufficient to let it terminate just south of the partition wall, the three outlets being visible at the far end of the room in Fig. 6 on the left-hand side just below the roof. The drawing room at the south end of the building is heated by direct steam, but there is no steam piping in the pattern shop proper. Metal lockers are provided for the use of the 30 journeymen and 8 apprentices employed in the shop.

Electric Glue Heaters

There being no steam piping, electricity was employed for heating the glue; in the shop are two electric glue heaters of the company's own design, shown in Fig. 9. Each of these heaters holds nine pots, the water being kept at a uniform temperature by four circulating loops, the heating surfaces of which are copper pipe encircled by No. 19 iron wires conveying electric currents, incased in mica insulation inside of asbestos pipe covering. A rheostat permits of accurate regulation of the temperature.

Work Done by the Shop

As already intimated, it is not often that one pattern shop is called upon to handle a greater variety of work than is this one, there being included all sorts of castings pertaining to the steel works and for the large amount of outside contracts which have been executed by the company, besides the shipbuilding and marine engineering work, which of itself is a very broad line. The largest pattern so far made in the new building is a blowing-engine bed; the company has been replacing its old Southwark walking-beam blowing engines by new and heavier engines. The new engines have the steam cylinders horizontal and the air cylinders vertical. The four new blast-fur-

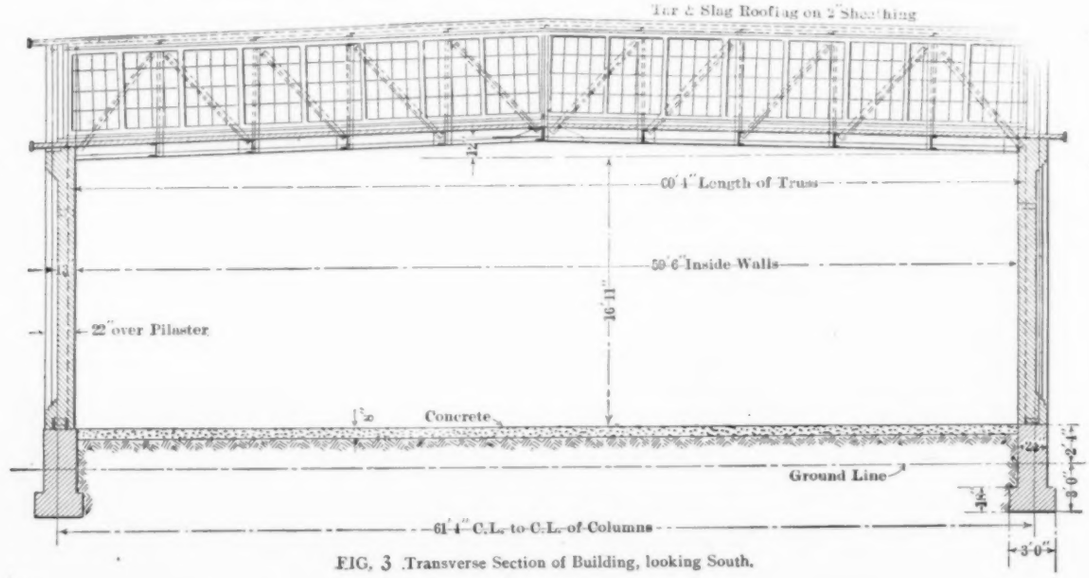

FIG. 3 Transverse Section of Building, looking South.

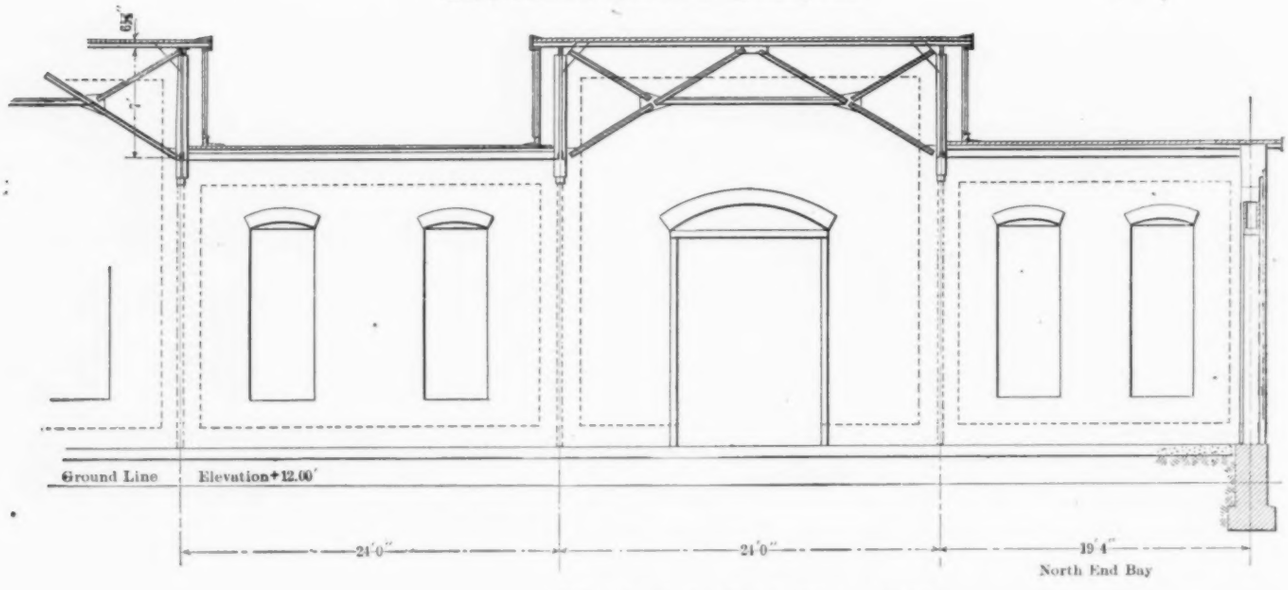

FIG. 4 Longitudinal Section of Portion of Building

SECTIONS OF PATTERN-SHOP BUILDING

nace engines are cross-compound, 44 and 81x60 inches, each having two blowing tubs 84x60 inches. The bessemer engines are not compound, but each of them has two 38x60-inch steam cylinders and a central vertical blowing tub 84x60 inches. The casting referred to is 27 feet 5 inches long by 10 feet 1 inch wide and about 6 feet high, and weighs 80,000 lbs.

The Drawing Room

The remainder of the building, 46 feet 5½ inches by 59 feet 6 inches inside, is occupied by the drawing room known as "No. 1." In the center of the room are large cabinets in which blue prints are kept for reference, the tracings being kept in the vault, the door of which opens on the drawing room. As already stated, this vault survived the fire; the walls on two sides, which were then on the interior of the building, are double, the inner wall being 22 inches, faced with firebrick, and later another 22-inch wall was

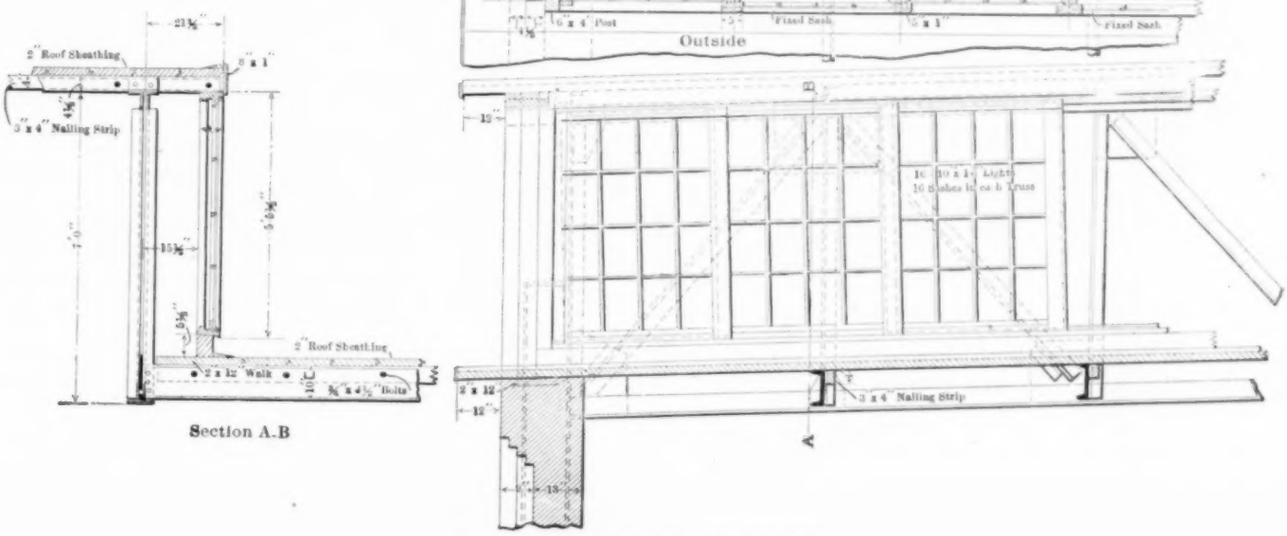

FIG. 5. DETAILS OF ROOF CONSTRUCTION

FIG. 6. INTERIOR VIEW OF PATTERN SHOP

added outside of this, with 4 inches of sand filled in between. It has double iron doors backed with asbestos. To circulate air and keep the vault free from dampness, an electric fan is provided in the doorway and kept running, so that in the hottest summer weather the apartment is still quite comfortable. The vault is, of course, lighted by electric lights.

The Blue-print Room

It was intended to have the blue-print room on the roof, but a small apartment has been fitted up on the ground floor and found to answer the purpose. Considering the number of prints required, it is a remarkably compact blue-print room, this being partly due to the arrangement of the apparatus and partly to the expedition with which the prints can be made, dried and sent out of the way. They are made on a Keystone arc-light apparatus, and for the washing and drying two homemade contrivances are used, which are here illustrated in detail.

A Blue-print Washer Which Saves a Lot of Floor Space

This is shown by the half-tone, Fig. 10, and line cuts, Figs. 11 and 12; it consists of a frame nearly 4x7 feet, making a small angle with the vertical, holding a heavy glass plate and having along its upper edge a 1¼-inch pipe perforated with many small holes so as to spray water on any prints which may be held against the glass. A trough at the bottom catches the water and conveys it to the drain pipe. Valves on the supply pipe permit of regulating the amount of water or of shutting it off. It is evident that here is a great saving of floor space over the usual large baths or tanks.

How Blue Prints Are Quickly Dried and Gotten Out of the Way

There is the usual wringer, which removes the greater part of the water from the prints; then instead of hanging them up on lines to dry, as the housewife does her clothes, they are attached by clothespins to wooden rods inserted in clips carried by Ewart link belts running over sprocket wheels on two horizontal axes, one about 5 feet above the other; the lower sprocket wheels are mounted on a shaft running in bearing brackets bolted to the partition, and the upper run on short studs carried by other brackets, as shown in the half-tone, Fig. 13, and line-cut, Fig. 14. The studs being used instead of a shaft at the top, there is no interference with the passage of blue prints across the upper semicircle. The crank on the lower shaft is turned; by the time the print makes its ascent and comes down on the other side, it is dry enough to be removed. Of course the print can be sent around again if necessary on account of very damp weather or any other cause. No floor space is used up for "clothes lines," the prints being hustled right out into the large room.

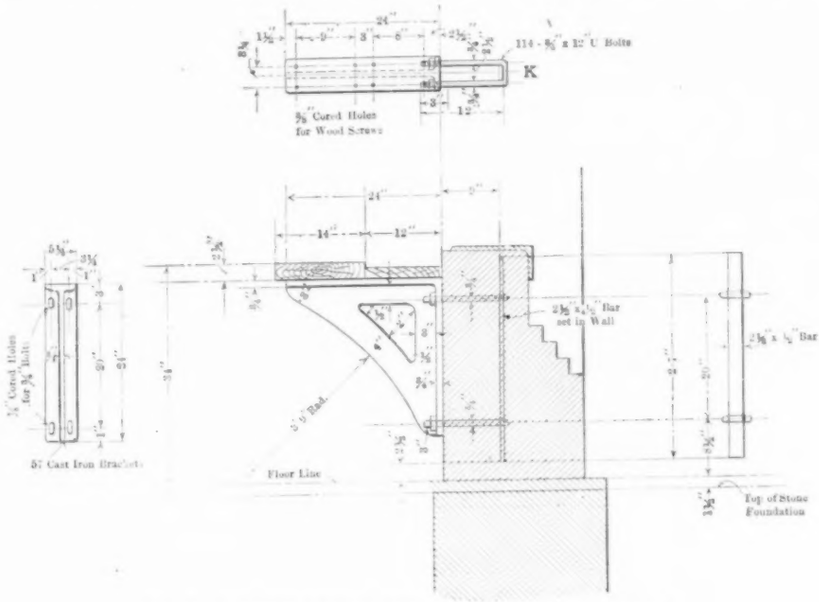

FIG. 8. PATTERN-SHOP BENCH AND SUPPORTING BRACKET

Good Blue Prints Quickly Furnished Without Waiting for Tracings

There has been considerable discussion regarding the practice of making drawings directly on bond paper and making blue prints from the bond paper, instead of the more common practice of making ink tracings from pencil drawings. Some experi-

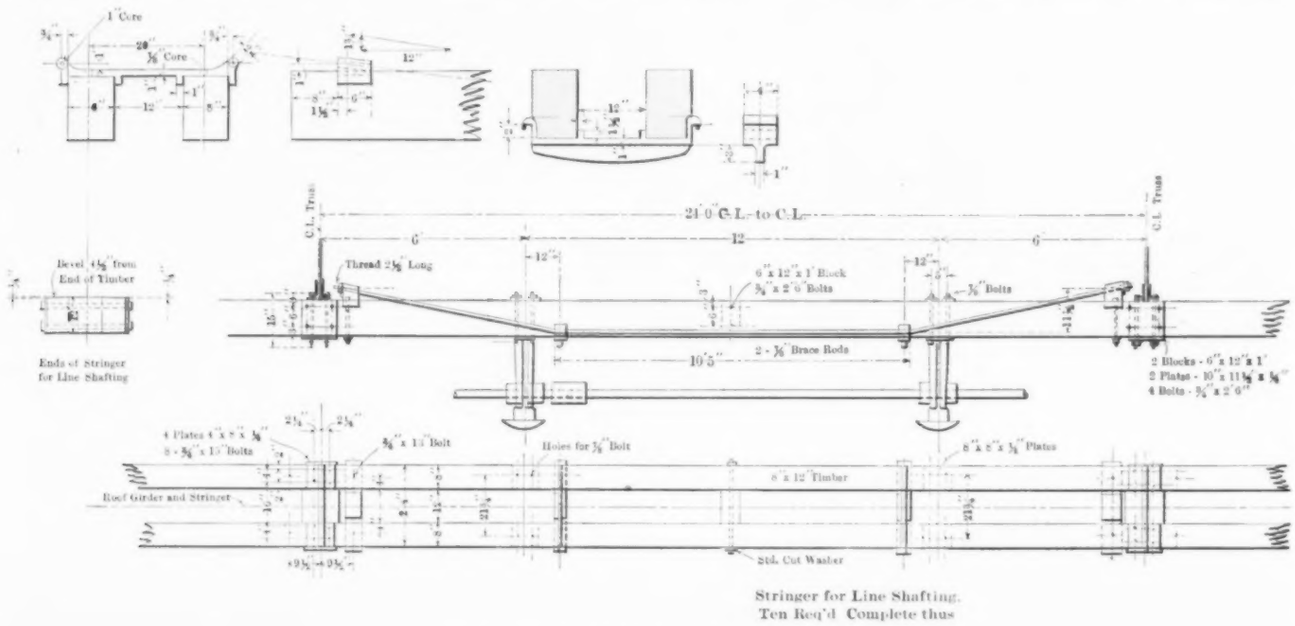
1" Core
⅜" Core
21'0" C.L. to C.L.
C.L. Truss
Thread 2½" Long
6" x 12" x 1" Block
¾" x 2'0" Bolts
⅜" Bolts
2 - ⅜" Brace Rods
10'5"
Bevel 4½" from End of Timber
Ends of Stringer for Line Shafting
2 Blocks - 6" x 12" x 1"
2 Plates - 10" x 11½" x ⅜"
4 Bolts - ¾" x 2'0"
4 Plates 4" x 5" x ⅜"
8 - ⅝" x 15" Bolts
⅝" x 13" Bolt
Holes for ⅜" Bolt
8" x 5" x ⅜" Plates
8 x 12" Timber
Roof Girder and Stringer
Std. Cut Washer
Stringer for Line Shafting.
Ten Req'd Complete thus

FIG. 7. DETAILS OF LINE SHAFT SUSPENSION

menting has been done in this drawing room along these lines, with the result of arriving at a practice, which, though it is true does not eliminate the tracer, is considered to fill their requirements very satisfactorily. The conditions to be met were the ability to furnish blue prints very quickly for new appliances for the plant, for experimental work, or for a foreign order; nevertheless it is usually desired to have a good durable record drawing from which good clear blue prints can at any time be obtained. Bond paper does not give first-class prints from ordinary drawing-pencil lines, and moreover it is not very fine stuff for making erasures and changes. After considerable experimenting, the material adopted for rush orders is a heavy tracing paper, known as "Vellum Tracing Paper," which gives very good blue prints from pencil lines, and in fact is so satisfactory that it is now used for the majority of the work, including many large and complicated drawings, with great numbers of lines on them.

For the sake of having uniform permanent records, it is their usual practice to make ink tracings on cloth from these drawings, which can be done at leisure, as the first blue prints are good enough for use on the job.

The size system employed starts with a sheet 30x42 inches, known as *A* size, which is used for general arrangements or large-scale details when necessary; the *B* size sheet is one-half the *A*, namely, 21x30 inches, and is used for small general arrangements and details; *C* and *D* sizes, 15x21 and 10½x15 inches respectively, are used for details; details of single parts where possible are put on the smallest size, 7½x10½ inches, known as *E*. The drawings of each size are numbered serially and independently of the other sizes, a consecutive number record being kept in a book; an ample card index, divided according to subjects, is provided for finding the tracings.

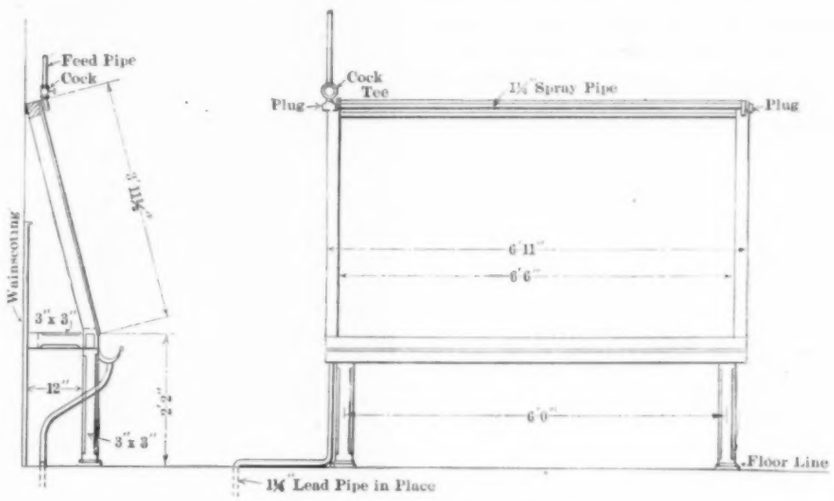

FIG. 11. FRAME FOR BATH GLASS

Titles are put on by impressing a blank form on the tracing by means of a rubber stamp and filling in the blanks in plain legible lettering without any frills and ruffles; there is no painful slaving away at elaborate hand-made standard titles, which in some places is insisted upon even when the poor draftsman has to work nights on some "rush" job. (Some of my readers have perhaps been in these delightful places.)

FIG. 10. BATH GLASS FOR RINSING BLUE-PRINTS; WATER RUNNING ON ONE SIDE

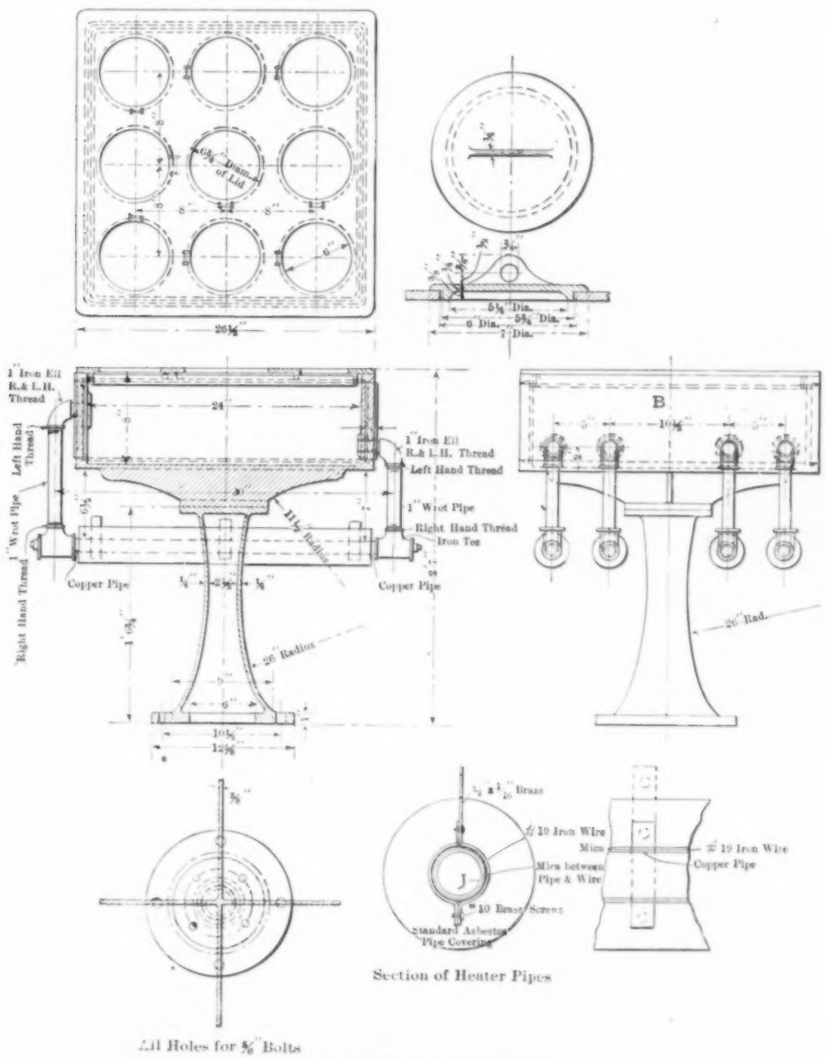

FIG. 9. ELECTRIC GLUE HEATER

The Use of "Sketch Books"

For small or rush jobs for which it is not important to have ink tracing records, sketch books are used, which in size are about 7½x10½ inches and contain over 100 leaves of cross-section paper, each of which is followed by three, thin, plain white sheets. By the use of carbon or manifold paper sufficient copies are made for the shop, the original remaining in the book and being numbered and indexed.

Delivery of Blue Prints and Handling of Shop Mail

The sending of blue prints to the points where they are to be used is taken care of by the very thorough works mail system, which also handles all orders for blue prints and for work, as well as letters and every other form of communication. The territory covered by the works is divided up into three different mail routes, and the carriers make round trips every hour, meeting at a central point for the exchange of mail destined to stations upon other routes than that on which it was mailed. Metal cylinders about 4x34 inches insure the protection of the prints against the weather. There are 41 mail stations, each having a box with compartments for incoming and outgoing mail. Though not quite as expeditious as the pneumatic tube, this system involves far less expenditure, and by means of it quite prompt delivery is very economically attained.

Tracing Blue Prints

There is a device used here, which, though not novel, should in my opinion certainly be used wherever there is much tracing of blue prints to be done. It expedites the work and from the tracer's standpoint it is a great boon, lessening the strain on the eyes from this often very trying work. It consists of a large frame containing a glass plate, adapted to be conveniently placed on a drawing table; on the glass the print and tracing cloth are placed and held by thumb tacks in the

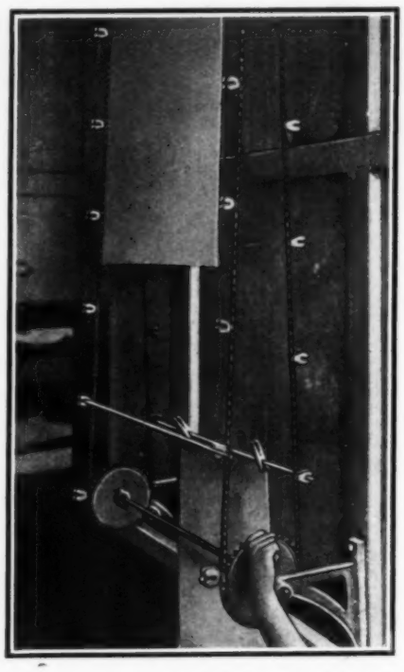

FIG. 13. TRAVELING RACK FOR DRYING BLUE-PRINTS

frame, and underneath there are one or more electric lamps.

Cabinet for Drawing Paper and Tracing Cloth

Though the design of the drawing-paper and tracing-cloth cabinet used in this drawing room is due to an article in the American Machinist, it has been found so convenient wherever used that it is not considered superfluous to show the drawing of it in this connection (Fig. 15). Upon one of the rods a roll of drawing paper is mounted, and the other rod carries a roll of tracing cloth. Through the slot in the bottom either of these is drawn out to the desired length as shown on the graduated scale, and can then be torn off against the pivoted knife-edged bar; if preferred, it can be cut by drawing a pocket knife along the slot, using the bar to hold the paper firm. The paper and cloth are placed in the box through the hinged front door. The rods with the rolls are readily lifted out or put in place.

Contiguity of Drawing Room, Pattern Shop and Foundry

Those concerned with the design and construction of patterns in this establishment have ample opportunity to keep in touch with the place where the patterns are used and to profit by this facility, the foundry being right alongside of the pattern shop, to the west. Its main portion is 75 feet wide by 47 feet high under the roof trusses and the crane runways extend out over the yard at each end. The bays on each side are each 35 feet wide; the building thus has a total width of 145 feet, and it is 210 feet long. One portion of it is occupied by the brass foundry; here, in addition to the usual crucible furnaces, are two tilting brass furnaces using oil fuel.

To South America during 1907 were sent large quantities of iron and steel manufactures from the United States, including railway rails of steel, 2¼ millions; wire, over 2 millions; builders' hardware, 2 millions; electrical machinery, 1¼ millions; sewing machines, 1⅓ millions; locomotives, 2 millions; and typewriters, nearly one-half million dollars' worth.

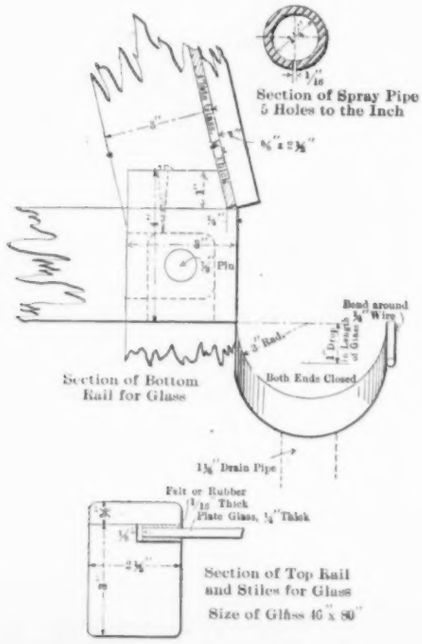
Section of Spray Pipe
5 Holes to the Inch
Section of Bottom
Rail for Glass
Both Ends Closed
Section of Top Rail
and Stiles for Glass
Size of Glass 46" x 80"

FIG. 12. DETAILS OF BLUE-PRINT WASHER

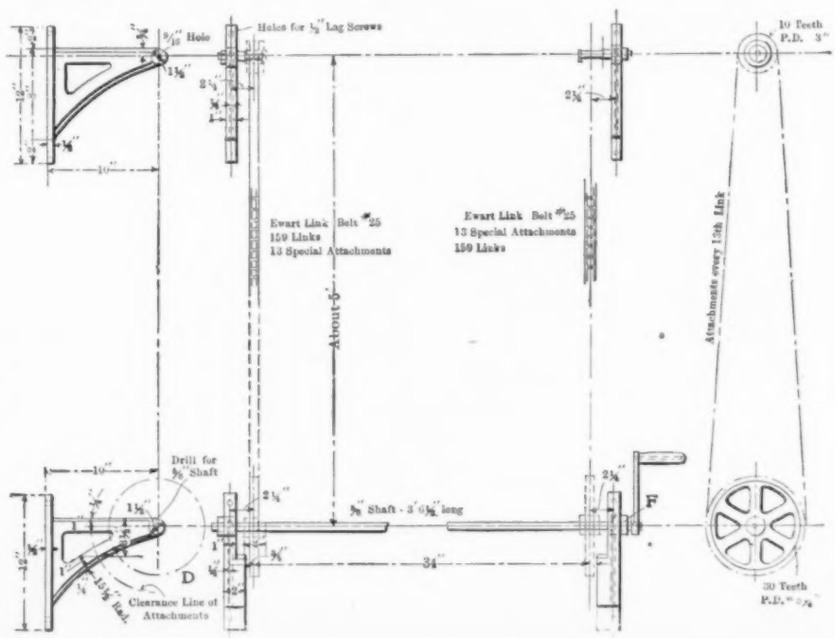

FIG. 14. GENERAL ARRANGEMENT OF BLUE-PRINT DRYER

Apprentice Training Versus Machine-operator Training

By Clinton Alvord

I have noticed much discussion in the American Machinist during the past few years in regard to the so-called rapid decrease in the number of machinists, and the consequent great necessity for good apprentice systems. Some years ago I considered that the apprentice system was the only solution of the problem for an increase in the number of efficient machinists, but I have been forced to change my mind because of the poor results attained. I will try to give the reasons that have led to this change of attitude. Machine-shop employees are not composed of first-class, all-around machinists. Manufacturing plants require skilled tool makers and some all-around men who can think for themselves and do any job to which they are put in a satisfactory manner; but the great majority of men are at one style of task most of the time, and thus become expert in that line. Mr. Osborne explained the value to the man of this knowledge of one machine in his article on page 23. A workman in the chucking department stays there; the lathe hands are seldom put on the upright or radial drills; milling machine and planer hands do not shift jobs.

Experiences with Apprentices

Six years ago I started my present line of business and installed a few bright young fellows as apprentices, although they were called boys and not known as apprentices. There was no written agreement, but the foreman promised to give them a good chance on a variety of machines. Arthur was the first one. He was a bright American lad. He stayed some three years, graduating from the hack saw to the milling machine, then to the upright drill and the lathe, but he was very careless and broke many tools besides spoiling lots of work. He understood quickly and was intelligent, but I could not walk down the other side of the shop and speak to the foreman without having Arthur follow me with his eyes and watch our every motion. This was the reason for many of the broken tools and much of the spoiled work. Talks by the foreman failed to cure him entirely of the habit. However, he was becoming valuable at the pay he was receiving. At length, because of his great carelessness, the foreman refused to raise his pay and he went off and got a job where they paid him 50 cents a day more.

Louis was somewhat older and came to us as a good milling machine hand; yet he knew nothing about strapping work to the table. All of his experience had been in putting work into fixtures and starting the machine after having been told on which step of the cone to run the belt. He knew nothing of speeds and never learned, but was quite faithful in attending to his duties and we considered him a fair milling machine hand after a year's experience with us. He later became dissatisfied and begged for lathe work. Two or three times the foreman gave him a show at this line of work, but his seeming lack of intelligence was such that there was nothing in it for us because he was slow; so slow as to be very expensive on the lathe even at small pay. When rush times came he got a place where they paid him 50 cents a

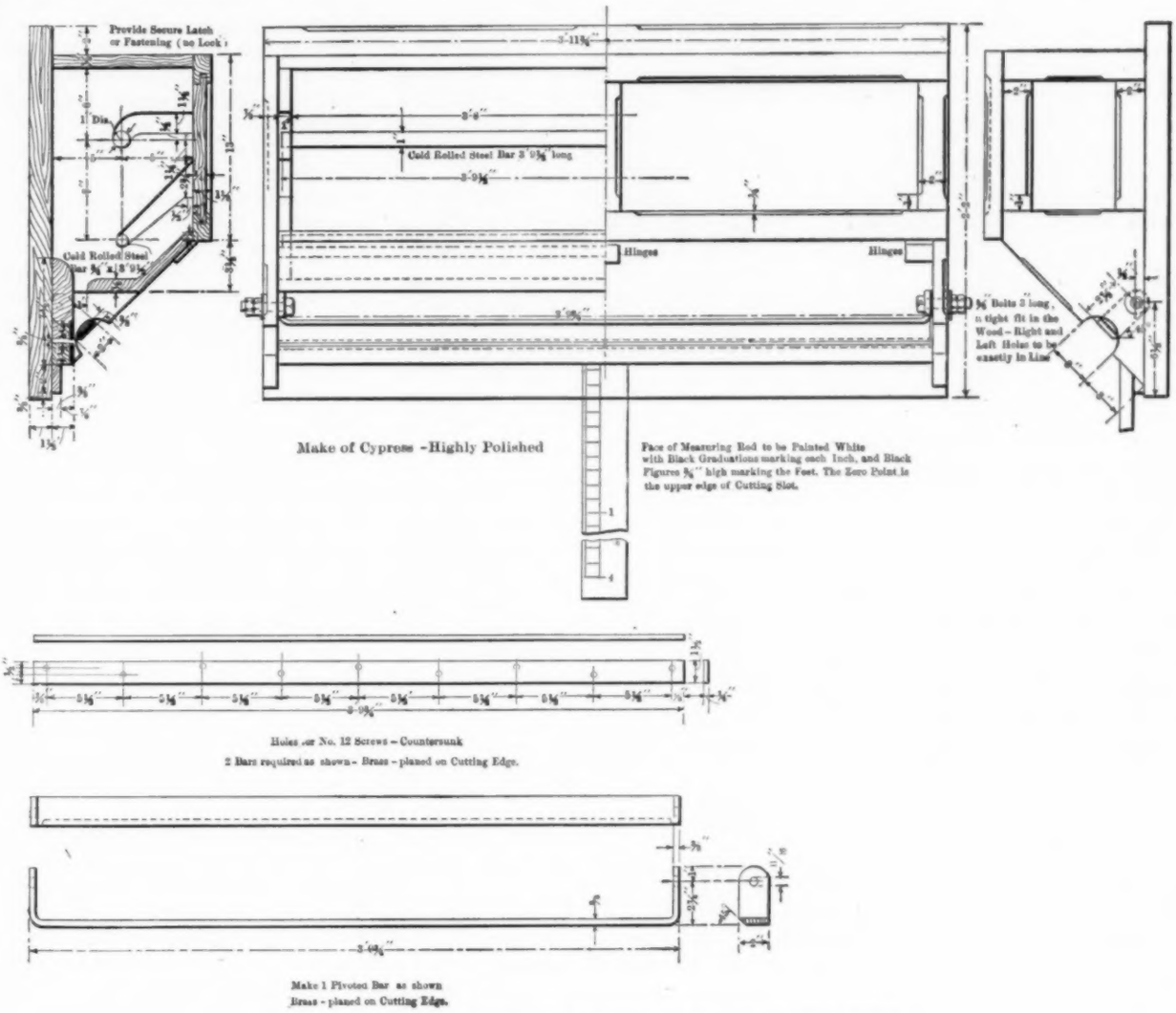
Provide Secure Latch or Fastening (no Lock)
Cold Rolled Steel Bar 3 9/16 long
Hinges
Hinges
Make of Cypress -Highly Polished
Face of Measuring Rod to be Painted White with Black Graduations marking each Inch, and Black Figures 3/4" high marking the Feet. The Zero Point is the upper edge of Cutting Slot.
Holes for No. 12 Screws - Countersunk
2 Bars required as shown - Brass - planed on Cutting Edge.
Make 1 Pivoted Bar as shown
Brass - planed on Cutting Edge.

FIG. 15. CABINET AND CUTTER FOR DRAWING PAPER AND TRACING CLOTH

day more. Three times since then he has come back apparently hunting for a job. Both these boys are at present tool makers in a shop of good reputation and we cannot but wonder as to what style of work they produce. We did our best to educate these young men and the education was costly for us; for as soon as they became fairly expert in one or more lines of their trade and began to return something on the investment represented by our care and labor in their education they left the shop for larger wages elsewhere; for wages we knew they could not earn in our shop.

Charlie came to us as a fair-haired Swede who had worked around a machine shop and had done rough planing for about a week. He put up counter shafts, installed machines and between times did some rough drilling. He teased for a chance on the planer and showed some intelligence after having been shown how to strap work to the platen. In a short time he could strap down a fairly complicated piece without springing it unduly and we raised his pay 25 cents a day. As he became more expert he asked for another quarter and received it, for he was doing good work; but we were educating him, helping him, driving him to produce more and better work each day. The "premium plan" of paying for labor was no small part of his education. Charlie got married and asked for another quarter and, as we thought he would now be even more steady, his hopes materialized again and his work did not deteriorate. Meanwhile things were booming and the neighboring shops were paying higher and higher wages for men. Nine months after Charlie first came to work for us he told the foreman that he would stay for another increase of 50 cents a day and if he did not get it he would leave. We had raised him 75 cents per day in less than eight months and had educated him into the bargain. I now felt that he was not worth another advance of 50 cents and it did not seem right to the rest of the men in the shop to advance this young fellow without advancing them. So, as prices did not warrant a large increase in the pay roll without corresponding increase of efficiency, Charles took the other job. He came in last week looking for his old place, for times are dull now and he was never good enough to hold the high pay he secured after he left us. I could give other illustrations to show that it has not paid us to educate ambitious boys and young men because they leave at the first opportunity for higher wages than they are worth to us, and we lose whatever we have put into their education.

I did not like to see this sort of thing going on and it was our experience with a different sort of man that compelled me to reconsider my first favorable conception of the apprentice plan (for ours was practically an apprentice system).

An Experience with a Laborer

Thomas had worked for me as a helper in another shop some 10 years before. He was a large, strong, apparently clumsy man. He came to work for us six years ago as a scratcher and helper and was glad to make $1.40 a day. He was diffident and showed great lack of self-reliance, but was trustworthy, and when asked to see that the windows were put down at six o'clock we soon learned that the windows would be down. His faithfulness led to a voluntary increase to $1.50 a day. The shop developed and more castings had to be handled, and his work of cleaning, carrying rough and finished castings and sweeping got behindhand from time to time. After the foreman had spoken two or three times about it Thomas threw up his job, saying that we were expecting too much of him. I had to explain to the foreman that Thomas had done the same thing in past years, that it was necessary to stroke his back a little, tell him that he was doing all right, and not to worry but simply to do all he could and leave undone whatever he did not have time for. During the next year and a half Thomas threw up his job as many as four times, but took hold again through the same course of treatment. He was now receiving $1.65 per day and the foreman had put him at rough drilling. These advances in pay had been voluntary on our part. When Louis was put on the lathe job the foreman suggested putting Thomas on the milling machine, urging it even against my opposition and saying that he thought the man had the ability even though he lacked self confidence. We were milling quantities of soft steel, using floods of solution, and the job was rather dirty and slimy. Arthur had made a record on this, Louis had beaten him, and now in a month or so Thomas had left their records away behind. He is still on the milling machine and is by far the best man we ever had. Besides receiving $2 a day he earns a fair sized extra amount in premiums. He handles his machine intelligently, can strap work well, and we trust him to show other men how to handle milling machines.

The failure of our style of apprentice system drew my thoughts quite strongly to the possibility of educating similar "doubting Thomases"; for he was a doubter in that he lacked self confidence to undertake new work, and in that it was necessary to urge him to try the machine. My foreman and I have come to the following conclusion: Pick out from among the more intelligent plain drilling hands and casting scratchers men who are 30 years or more of age, and preferably married; men who are faithful workers and not lazy, and train them for machine operatives or machinists. If they have intelligence, are steady workers and steady in their habits, but have not advanced beyond low pay, the chances are that it is a lack of self confidence that has kept them in the lower planes of machine-shop work. These are the men who pay large returns on the time, trouble and money expended in their education. They are grateful for the chance to improve their condition and at the same time their lack of self confidence tends to keep them in our shop. They are not really ambitious except to hold the better jobs to which we have educated them; they become expert and we depend on them and they return our confidence in a good measure. Their teacher, the foreman, must, however, be a man of insight and patience.

The superintendent of a large tool shop in the West told me, some two years ago, that his experience had been exactly similar; that they had stopped trying to educate boys and were devoting themselves to the education of married men 30 to 35 years of age.

Conclusions

A brief summary presents our conclusions as follows:

It seldom pays to educate boys and young men in the machine shop because they leave at the first opportunity afforded by good times and high wages; leaving when their services are most needed.

It pays decidedly to educate the older married men and especially the faithful, intelligent ones who show lack of self reliance.

This view of the case is horribly selfish, but at the same time it is business-like. The majority of men in any manufacturing plant are employed in one line of work and it is difficult to secure new men who are expert in handling any one machine. It is the work of these "one machine men" that the management of the plant looks to for his paying production. Therefore, it is no more than common sense for a shop manager to study some plan for the proper means of increasing the supply of this sort of skilled labor.

My experience has been duplicated, consciously or unconsciously, in many shops, and for one I am willing to stand for all the selfishness this course of procedure may show. At the same time I know that the education of these men is just as fine a thing for them as it is for us; that both parties secure the recompense due their efforts.

The origin of the establishment of the needle industry in Redditch, which town is now famous for its needle production, is uncertain, but recent researches seem to show that the art of needle making was probably first taught to the inhabitants by the monks of the Cistercian Abbey of Bordesley, which was a large religious house existing on the outskirts of the present town of Redditch, and which was dissolved in 1538. The growth of the trade, however, must have been very slow, and it was not until toward the end of the eighteenth century that the bulk of the English needle-making industry was concentrated in and about Redditch.

Automatic Screw-machine Turning Tools*

How Box Tools with Tangent and Radial Cutters and Hollow Mills Are Made and Applied to the Automatic

BY C. L. GOODRICH† AND F. A. STANLEY‡

The accompanying engravings illustrate a variety of so termed box tools and hollow mills which are used in automatic screw machines, and in much the same form in hand machines also. It is the purpose of this article to point out some of the reasons for different designs and to show for what particular cases each type of tool illustrated is best adapted.

General Principles

Practically all box tools consist primarily of a frame or body which is clamped to the turret of the screw machine. The box-tool frame is utilized for holding the cutting tools and, usually, a work-supporting device commonly known as a back rest. In the frame there is also in some instances provision made for holding internal cutting tools such as drills, counterbores, etc., in this latter case outside turning and boring may be accomplished simultaneously. The cutting tools are usually adjustable so as to be suitable for turning various diameters; the back rests or work-supporting devices are made both adjustable and solid or non-adjustable. Both cutting tools and back rests are preferably mounted in sub-holders permitting of longitudinal adjustment. The most common turning tools in use are for cylindrical work, but taper work can also be successfully produced by box tools designed for the purpose.

Conditions of Service

The type of box tool in general, as well as such features as the work-supporting device and the manner in which the cutting-tool edge is presented to the work, are dependent upon various conditions, among which may be mentioned:

1. Length of work being turned;
2. Uniformity of diameter of stock used (bright drawn or rough stock);
3. Cross-section of stock (circular or otherwise);
4. Character of material;
5. Reduction in diameter to be made;
6. Character of longitudinal cut (cylindrical, taper or other).

Before explaining the reasons why the foregoing conditions should influence the design of tool, it may be well to understand precisely by name the various parts which are frequently referred to later on. To this end a few of the different types of box tools and component parts, as shown by Figs. 1 to 8, will first be briefly described.

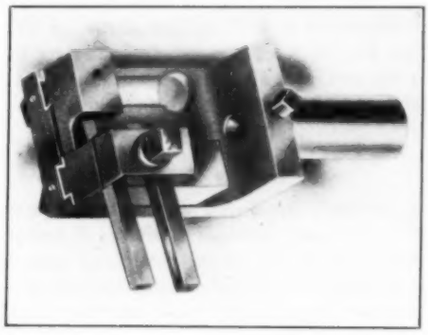

FIG. 1. NON-ADJUSTABLE ROUGHING BOX TOOL

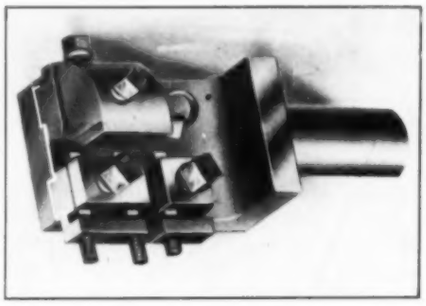

FIG. 3. ADJUSTABLE FINISHING BOX TOOL

Types of Box Tools

Figs. 1 and 2 illustrate a box tool with movable blocks holding the cutters and with a back rest of the non-adjustable open type. The cutting edge of the tool is practically radial, but longitudinally the

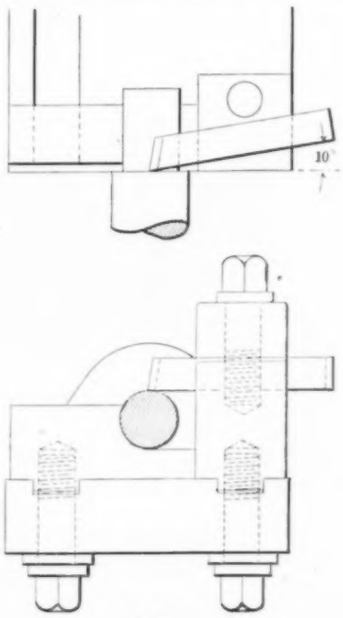

FIG. 2

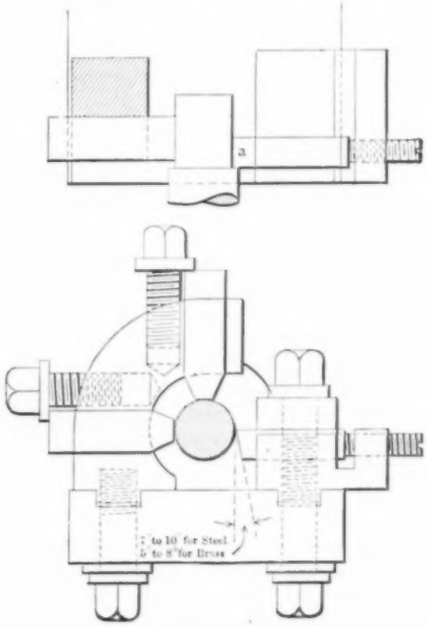

FIG. 4

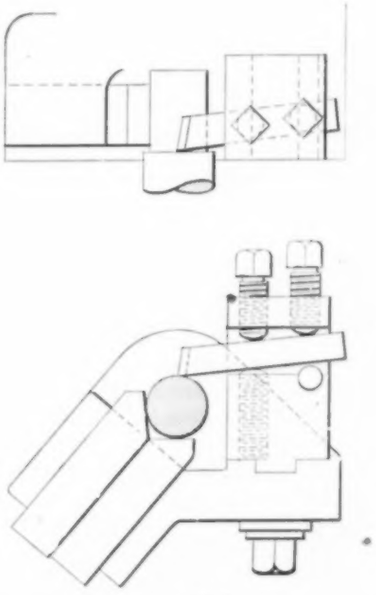

FIG. 5

BOX-TOOL RESTS AND CUTTERS

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†Department foreman, Pratt & Whitney Company.

‡Associate editor, AMERICAN MACHINIST.

cutter lies tangent to the circle representing the work. This tool is commonly called a roughing box and is recommended for heavy cuts as there is less danger of springing, due to the strain on the tool in cutting, than in the case of the radial tool in Figs. 3 and 4. The latter tool has movable blocks holding the cutters and movable blocks carrying the back-rest jaws. Both cutters and back-rest jaws may be adjusted to suit different diameters of work. The cutting edge of the cutter is radial to the work and is parallel with the longitudinal section of the cutter. The tool is used mostly for brass and similar

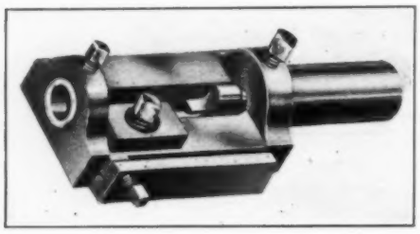


FIG. 6. BUSHING BOX TOOL

material and for light cuts on steel, and is in this general form commonly known as a finishing box. On very free-cutting materials such as brass, the edge of the cutting tool is generally presented to the work without any rake, as shown in Fig. 4. In cutting the harder materials, steel, etc., and especially in taking roughing cuts on such material, rake is desirable; hence the tool of the roughing box is presented to the work in the manner shown by Fig. 2.

The tangent cutter used in the box tool shown in this view and in Fig. 1 is sharpened by grinding on the end, and compensation for the grinding away of the metal is made by adjusting the cutter forward, whereas in the radial type of cutter in Figs. 3 and 4, frequent sharpening cannot be done without resulting in lowering the cutting edge of the tool below the center of the work, unless a substantial part of the tool be sacrificed. The radial tool, however, is easily ground accurately on face *a*, which is the particular edge governing the finish; while the corresponding face on the tangent type of tool is rather difficult to grind so as to produce as smooth work.

Other Forms of Box Tools

Fig. 5 outlines the general scheme of a box tool with tangent cutter having means of radial adjustment for various diameters, the back rests being adjustable also, as indicated.

In Fig. 6 we have a box tool with a back rest of the hushing type which fully envelops the work. A bushing like that shown in Fig. 7 is frequently used in the bushing type of box tool. This bushing is tapered externally and drawn into a conical hole, and is thus suitable for slight variations in stock sizes. Fig. 8 shows another "solid" rest, but without a bushing. The question of chip room frequently makes it necessary to abandon the bushing and bore the hole for the stock directly in the back rest. Quite often the back rest is cut away to allow the tools to operate on a second shoulder cut; then the bushing as ordinarily made interferes. As a rule, it is preferable to use the bushing where possible, owing to the ease with which it may be replaced when worn out of shape and also because of the facility with which any changes due to hardening may be corrected.

Other types of work-supporting devices, such as internal stem rests, etc., are very commonly used. Fig. 9 illustrates such a combination. Frequently, too, revolving stem rests are used in place of the stationary type shown. Quite often a drill or counterbore is held in the shank of the box tool in a similar manner and acts as a support and also, as before stated, enables turning and boring operations to be accomplished simultaneously.

Selection of Back Rests

Generally speaking, work that projects over one and one-half times its diameter from the spindle chuck cannot be turned accurately or rapidly without the aid of a support which will prevent the work springing away from its proper radial relation to the edge of the cutting tool.

Usually on work which does not project over five diameters from the chuck, the back rest is located so as to support the work by the diameter produced by the first cutting tool in the box tool, the back rest being set from about 1/64 inch to 1/32 inch back of the cutting tool, as in Figs. 2 and 4. While any of the types of back rests shown in Figs. 1 to 8 may be used, on work of the length mentioned an enveloping back rest is not required. The type of back rest used in the tool in Figs. 3 and 4 is adjustable for wear and preferable on this account. The non-adjustable open back rest, Figs. 1 and 2, is recommended only when the design of the tool makes it difficult to utilize an adjustable type. All back rests should be of tool steel. They should be very hard and smooth; otherwise when used on fast running material such as brass, a welding action takes place. They should be ground and lapped on the bearing face so as to bear more strongly on the forward end of the work than at the rear. The clearance need not be more than 0.003 or 0.004 inch to the foot. Should the back rest be bell mouth, the work turned will be rough and covered with ridges.

FIG. 7. Bushing

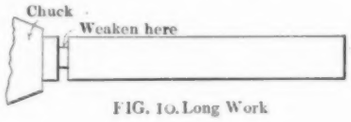


FIG. 10. Long Work

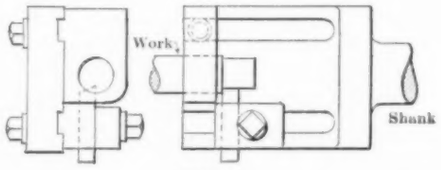


FIG 8

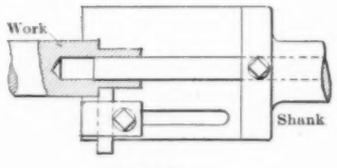


FIG. 9.

OTHER TURNING METHODS

Tool Position, Lubrication, etc.

Also it is quite important, where using such rests, that the work be not turned too large if roughing up of the surface is to be avoided. About 0.0005 inch freedom should be allowed for work up to ½ inch diameter, and about 0.001 inch freedom for 1 inch diameter. Proper lubrication of the bearing is also essential in preventing roughing up of the work. Lack of alinement of solid or half-open rests with the spindle of the machine may also cause the production of poor surfaces on the work, owing to the heavy crowding action under such conditions.

In setting adjustable back-rest jaws it will be found conducive to good work to hold a bar in the head spindle, turn a true running piece of work from 0.0004 inch to 0.0008 inch oversize and then adjust the jaws so that they will bear snugly on the turned part. The closer this is to the spindle the better. In using solid or non-adjustable open-back rests, as shown by Figs. 1, 2, 6 and 8, it is recommended that they be bored out while held in the turret hole of the machine that they are to be used in. This insures the hole being in alinement with the head spindle; these conditions, as well as having the turret slide travel parallel with the axis of the head spindle, are necessary in order to produce accurate work.

Burnishing of stock generally results from the pressure of the cutting tool forcing the work against a closely adjusted, smooth back rest and is usually considered an evidence of proper adjustment. Frequently, however, this is found not to be the case.

Long and Short Work

On very long work when bright-drawn cylindrical stock of uniform diameter is

being turned, the solid back rest is found very satisfactory. The rest is in this event set ahead of the cutting tool and fully enveloping the work. It obviously prevents any tendency for the work to spring away. Where heavy stock which does not run true is to be machined, it is necessary before turning partly to cut off, as shown by Fig. 10, thus permitting the back rest to pull the bar into central position. In case there are short bends in the bar, trouble will be met, so that for long work machined in this manner it is necessary to select straight bars. It is also important where a back rest is used ahead of the cutting tool (that is, where the unmachined bar rotates directly in the back rest) to select practically uniform diameters of stock, not varying in size over 0.0004 inch to 0.0008 inch. In many large screw factories all bright-drawn stock is carefully gaged as soon as received and sorted out in this manner; in setting up the machine a back rest is selected to suit a particular bundle of gaged stock.

Irregularity of Stock Section

Where bright-drawn stock is used which is slightly out of round, as is very frequently the case, the use of a full enveloping back rest preceding the cutting tool will be found superior to the jaw type, giving a two-point bearing. In the former case the pressure of the tool cannot force the work away and the turned part will be cylindrical; whereas with the jaw type of back rest the pressure of the cut will keep the irregular contour of the bar against a jaw and consequently reproduce a similar cross-section to the turned part. This emphasizes the value of using back-rest jaws so as to follow the cutting tool; but as before noted, their use is limited to short work and work of medium length. In such work if the back-rest jaws are properly set and the turret slide travels parallel with the axis of the head spindle, true work will result irrespective of the collet or turret hole being out of line with the spindle.

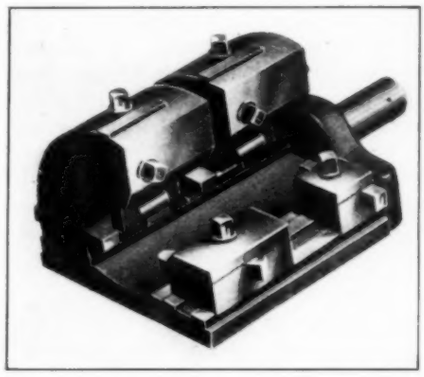


FIG. 11. BOX TOOL WITH ROLLER REST

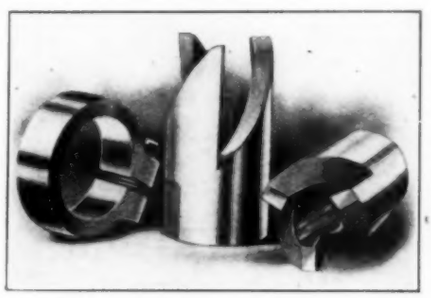


FIG. 12. HOLLOW MILLS AND CLAMP COLLAR

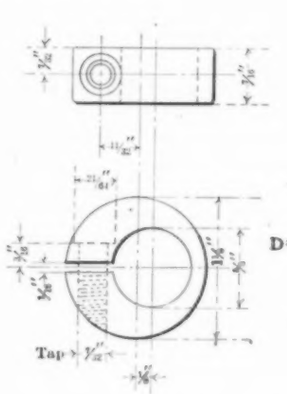
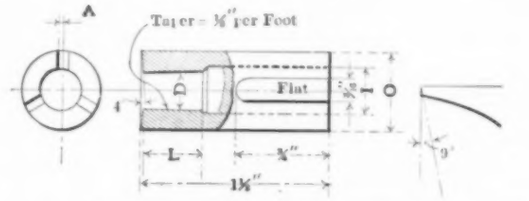


FIG. 13



D =	Finishing	1/16	3/32	1/8	5/32	3/16	7/32	1/4	5/32	5/16	3/8	1/2	5/8	3/4
	Roughing	.072	.104	.135	.166	.197	.229	.26	.291	.322	.385	.510	.635	.760
L =		1/4	1/4	5/16	5/16	3/8	3/8	7/16	7/16	1/2	1/2	1/2	1/2	1
A = D/10 =		.006	.009	.012	.015	.019	.022	.025	.028	.031	.038	.050	.063	.075
I =		3/16	3/16	3/16	3/16	3/16	1/4	1/4	1/4	1/4	5/16	5/16	11/16	13/16
O =		3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	1	1⅛	1⅜	1⅝

FIG. 14

CLAMP-COLLAR AND HOLLOW-MILL DIMENSIONS

Cast-iron Work

In machining cast iron, as on the magazine automatic, box tools with the ordinary types of rests are not satisfactory, owing to the fact that the cast-iron dust is apt to become ground between the rest jaws and the turned part of the work, thus causing the latter to become roughed up. The use of water, however (with just enough oil to prevent rusting), or any thin solution under pump pressure, effectively overcomes this trouble; oil seems to increase the difficulty.

A box tool with roller back rests, which is excellent on cast-iron work when used in conjunction with an air blast to keep dust from accumulating between the rollers and work surface, is shown in Fig. 11. This box tool as sometimes used on the Pratt & Whitney magazine machine, may be stiffly supported at the bottom by a hardened-steel plate carried on a bracket attached to the front end of the turret slide and traveling with the slide. Another satisfactory way of turning cast iron is by means of hollow mills.

Hollow Mills

Hollow mills are also very suitable for turning long work from bar stock. These tools with multiple teeth support the work centrally, cut very rapidly, and if held concentric with the head spindle and properly cleared, will produce excellent results.

Fig. 12 illustrates a form of hollow mill. The clamp collar shown in the group is commonly used for slightly adjusting the teeth to cut to correct diameter. Another good form of clamp ring is shown in Fig. 13. This is made with sufficient metal at one side to admit the clamping screw, while the opposite side of the ring is weak enough to allow it to close properly upon the mill when adjusted by the screw.

The teeth of hollow mills should be radial or ahead of the center. With the cutting edge ahead of the center, as in Fig. 14, the chips as produced are caused to move outward away from the work and prevented from disfiguring it. With the cutting edge below the center, rough turning will result. With the cutting edge greatly above the center, chattering is produced. About one-tenth of the cutting diameter is found a good average amount to cut the teeth ahead of the center. When the chips produced from any turning or boring cut curl nicely, it is indicative of a free cutting action; but these chips are very troublesome on the automatic screw machine. In making hollow mills for the automatic, part or all of the rake to the cutting edge is generally sacrificed.

Hollow-mill Proportions

The table under the hollow-mill sketch in Fig. 14 gives proportions of mills from 1/16 to ¾ diameter, showing the amount to cut the teeth ahead of the center, the amount of taper in the hole, etc.

Besides the type of mill shown made in one piece, hollow mills are often used with inserted blades of high-speed steel. These tools are especially useful on the larger sizes of work.

Taper-turning Tool

So far we have discussed conditions where cuts are cylindrical and where box tools with stationary cutting tools and back rests are suitable. On taper work the cutting tool must move radially; the back rest, unless it precedes the cut, must be so constructed as to adjust itself to the increase or decrease in diameter.

Fig. 15 illustrates a type of box tool for taper work which is suitable when uniform bright-drawn stock is used. The back rest consists of a stationary bushing fully enveloping the bar. The hole should be about 0.0005 oversize and nicely lapped. The cutting tool is held in a transverse sliding member, the cross movement to the slide being controlled by

a taper bar mounted on the cross slide of the screw machine. The taper bar is sometimes made in two pieces which may be adjusted in such a manner as to permit varying angles of tapers to be produced. This tool allows only one cut to be taken over the work unless the support from the back rest is dispensed with.

Some Points in Back-rest Construction

Having now illustrated various types

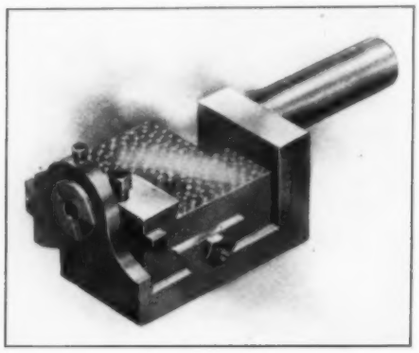


FIG. 15. TAPER-TURNING BOX TOOL

of box tools and their rests, hollow mills, etc., a few words relative to the actual making of certain box-tool parts may be of interest.

In making back rests of the quarter-bearing type, as shown by Figs. 1 and 2, the usual custom is first to bore out the solid block from 0.0005 to 0.001 inch over the size that is to be turned and plane away the portion indicated at *A*, Fig. 16. The hole should be very smooth and cylindrical. Low-carbon tool steel is very good for the purpose, providing the work is pack hardened; otherwise it is preferable to use high-carbon steel and harden in an open fire.

After the back rest has been hardened and assembled in the box-tool frame, the bearing may be slightly lapped with emery by holding a cylindrical piece of brass of correct diameter in the screw-machine chuck. The turret slide being moved back and forth will very quickly cause the lap to correct any slight crookedness due to the hardening.

When an exceptionally nice job is required, the back rest may be hardened after cutting in, as at *B*, Fig. 16; afterward by using a slitting emery wheel made by the Ramsdell Specialty Company, of Worcester, Mass., the corner may be removed entirely, leaving a little over the quarter bearing.

It is found good practice to give back rests a width equal to one or one and one-half times the diameter of the work they are used on. It often happens, of course, that the positions of the cutting tools necessitate the employment of two rests in one box tool.

Box-tool Cutters

It may be stated that present-day practice favors the use of high-carbon steel for the radial type of tools and high-speed steel for tangent cutters on heavy roughing cuts.

Sections recommended for box-tool cutters are as follows: For box tools used for stock diameters up to 5/16 inch, 3/16 inch square; up to ⅜ inch diameter, 7/32 inch square; up to ½ inch diameter, ¼ inch square; up to ¾ inch diameter, 5/16 inch square; up to 1 inch diameter, ⅜ inch square; up to 1½ inches diameter, ½ inch square.

The "Tangent" Cutter

While the box tool shown in Figs. 1 and 2 has been called the tangent tool, actually the cutter should not be exactly tangent to the diameter to be turned, as it is then impossible to adjust this type of cutting tool so as to cut under size, although by withdrawing the tool oversize work can be turned. In order to be able to compensate for slight errors and to insure that work may be turned to fit the non-adjustable back rest, it is the practice to plane the cutter block so that the cutting edge of the tool is about 0.002 inch to 0.003 inch below a line tangent to the diameter actually to be turned, as at *C*, Fig. 17.

The effect of in-and-out adjustment of the cutter is clearly shown by Fig. 18.

An Operating Suggestion

In order to facilitate the "starting on" of the box tool, it is well to have the end of the work beveled, as in Fig. 19. The forming tool in finishing the head of the work simultaneously bevels a portion of the bar at E^1 which, when a new piece of work is being produced, becomes E^2. The first cut of the box tool is thus made light and does not become heavy until after the support of the back rest has been secured.

Fig. 20 illustrates an end-pointing tool used on the type of box tool just referred to. The form is planed in the end of the cutter as indicated, thus permitting frequent grinding without altering the form. Sometimes for pointing work a special pointing box tool is employed, carrying merely a back rest and a pointing cutter; frequently a regular roughing box tool is utilized and the pointing cutter held in

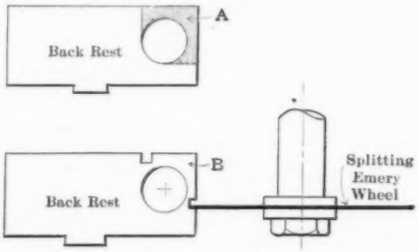
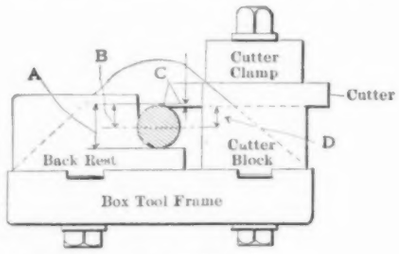


FIG. 16. CUTTING OUT CORNER OF BACK REST

the hollow shank and prevented from moving by a set-screw.

It is estimated that the annual output of needles in the Redditch district probably exceeds 2,000,000,000. The population of this town in 1901 was 13,493, of which number about half were connected with the needle industry. A large proportion of women are employed, the light and clean character of the work being well suited to their capabilities. A peculiar requirement of employees in this industtry is to possess dry hands, as otherwise the continual handling of the needles would be liable to rust them. It is interesting to note that nature has adapted the descendants of the early needle makers in this vicinity by endowing them with dry hands.



A = Full Diameter of Work
B = Half " " "
C = Amount Cutting Edge of Cutter is below a Line Tangent to Diameter of Work. (.002" to .003")
D = B-C

FIG. 17

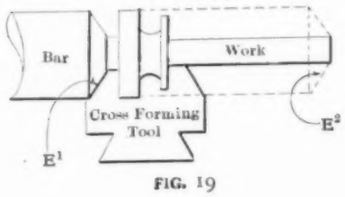


FIG. 19

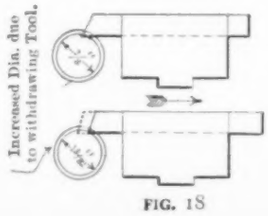


FIG. 18

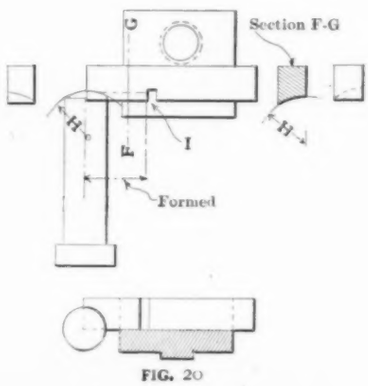


FIG. 20

BOX-TOOL CUTTERS

Practical Letters From Our Readers

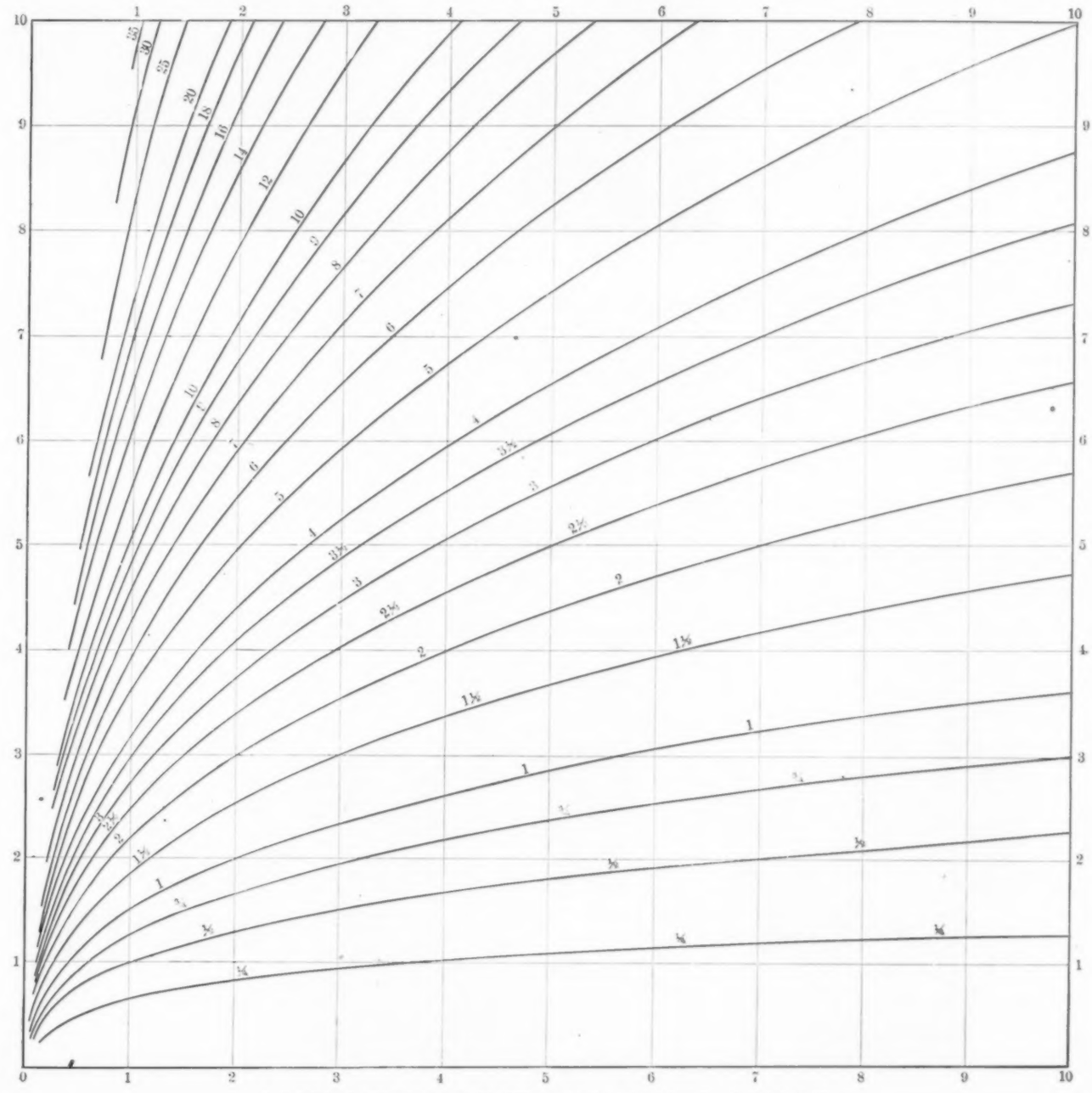
A Round Table Discussing Details of Modern Machine-shop and Drawing-office Methods, Practice and Economy

WE PAY FOR USEFUL IDEAS

Diagram for Determining the Radii of Arcs for Drawing Ellipses by the Four-arc Method

The accompanying diagram will give the proper radii for drawing approximate ellipses by the four-arc method. To use it, find the length of the major axis on one side of the sheet and the length of the minor axis on the top or bottom. Follow the corresponding horizontal and vertical lines to their intersection and read on the curved lines or by interpolation the radius of the larger arcs. Then find the length of the minor axis on one side of the sheet, and the length of the major axis on the top or bottom. Follow the corresponding horizontal and vertical lines to their intersection and read on the curved lines the radius of the small arcs. In many cases it may be found more convenient to put in the small arcs by the cut and try method, as it is a simple matter to draw in arcs which will connect the large arcs and pass through the ends of the major axis.

The method of constructing the diagram was as follows: A number of true ellipses were laid out, in which the ratio of the minor to the major axis varied from $\frac{1}{10}$ to 1, the major axis being kept constant. These were then approximated as closely as possible by four circular arcs and the lengths of their radii noted. Then a curve



LENGTHS OF ARC RADII FOR DRAWING ELLIPSES BY THE FOUR-ARC METHOD

was plotted between the ratios of the axes as abscissas and the length of the major radii as ordinates, and an equation found which closely expressed this curve. For a length of major axis equal to unity the equation is:

$$l = \frac{0.35 + 0.15\,K}{K}. \qquad (1)$$

in which l = *the length of the longer radius,*

and K = *the ratio of the minor to the major axis.*

Now let a = *the length of the major axis* and b = *the length of the minor axis.*

Then since the required radii are proportional to the lengths of the axes, for an ellipse of given shape, equation (1) becomes:

$$l = \frac{0.35 + 0.15\,K}{K} \times a. \qquad (2)$$

But $K = \frac{b}{a}$.

Substituting in (2):

$$l = \frac{0.35 + 0.15\,\frac{b}{a}}{\frac{b}{a}} \times a =$$

$$\frac{a}{b}\ (0.35\,a + 0.15\,b). \qquad (3)$$

It was found that equation (3) still holds good when b becomes greater than a; so if we let B represent the length of the axis at the end of which the required arcs are to be drawn, and A the other axis, equation (3) becomes:

$$l = \frac{A}{B}(0.35\,A + 0.15\,B), \qquad (4)$$

which holds good for finding the radius of either the large or the small arcs.

The diagram was constructed according to equation (4).

Philadelphia, Penn. S. JAY TELLER.

A Gear-hobbing Machine 15 Years Old

I notice considerable attention is being given to the cutting of spur gears with worm hobs. As a machine of this type has been in successful operation for 15 years in the shops of Geo. Juengst & Sons, Croton Falls, N. Y., I thought perhaps a photograph of it would interest you.

The machine in the foreground, Fig. 1, has been in constant use for the past 15 years; a smaller experimental machine, built before this along the same lines, was later converted into a worm-milling machine. The one in the background has been in use about six years. Both these machines were designed and built in this shop.

The worm hob is mounted on a carriage the top portion of which can be swiveled horizontally to the angle of the thread on the hob. The gear blanks are mounted on a horizontal arbor which extends through to the back of the machine, and which is driven by a large worm wheel through change gears shown at the left side of the column near the top. These change gears determine the speed of the gear blank and consequently the number of teeth cut in the gear.

The hob is fed from the front of the blank toward the rear by means of a

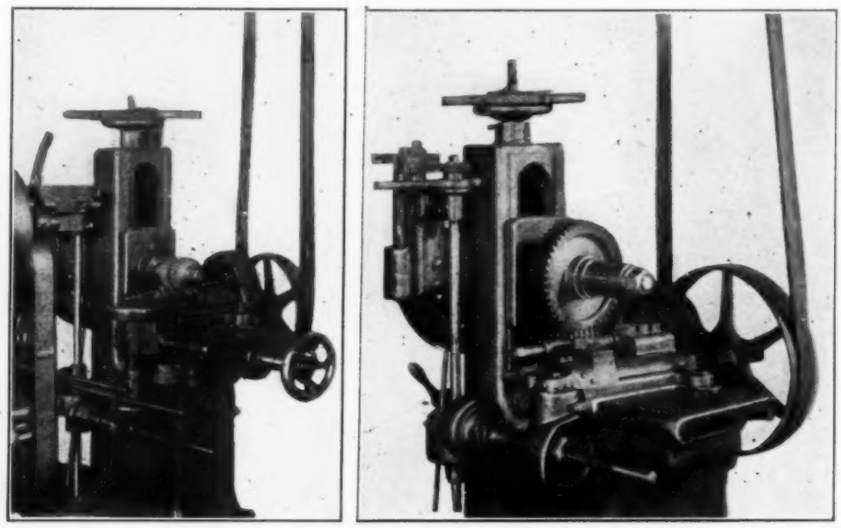


FIG. 1. GEAR-HOBBING MACHINE IN USE 15 YEARS

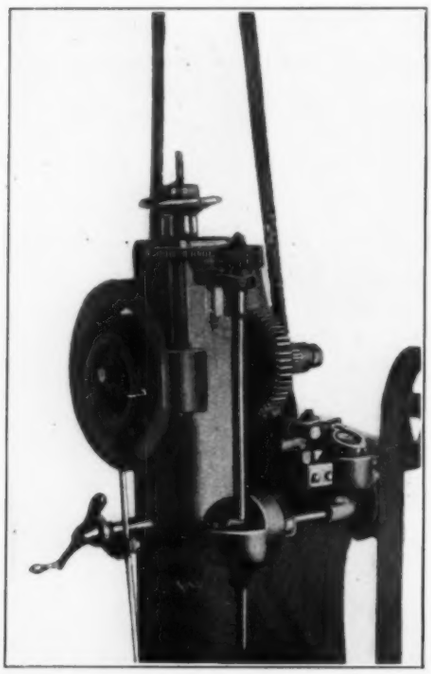


FIG. 2. RATCHET FEED DRIVEN ECCENTRC

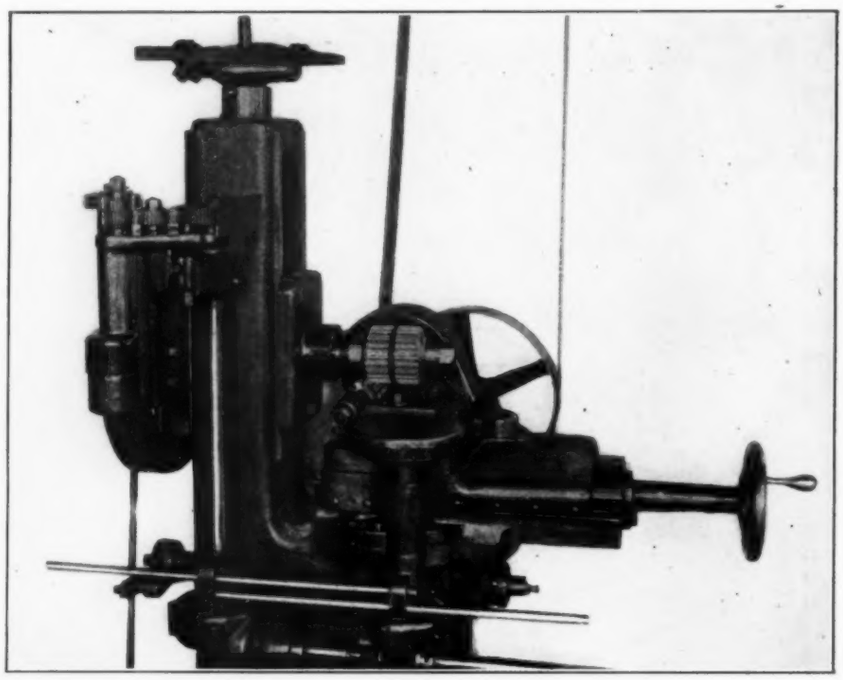


FIG. 3. DETAILS OF CUTTERS AND WORK FEED

screw under the carriage. This screw is driven by a ratchet operated by an eccentric fastened on the rear of the large worm wheel, as shown in Fig. 2. The thrust of the cut is taken by a small thrust plate bolted to the column and bearing against the rim of the gear just behind the hob.

Fig. 3 is a side view of the newer machine. On this machine it will be noticed that the ways which guide the cutter carriage are formed on a casting which is separate from the main column and can be swiveled horizontally to a considerable angle. This is for cutting spiral gears within this range, the ways being set to the required angle of the gear teeth. The change gears for rotating the blank are figured the same as for a spur gear of an equal number of teeth, all operations being the same as for cutting spur gears, with the exception of feeding the hob across the blank at an angle. When cutting worm wheels, the vertical screw is used to feed the blanks down on the hob; at other times this screw is used to adjust the arbor carriage to the proper vertical position for the gear to be cut.

The work which has been done on these machines ranges from pinions 2 inches up to gears of about 28 inches diameter, and in pitches from 12 diametral to 1¼ inches circular pitch.

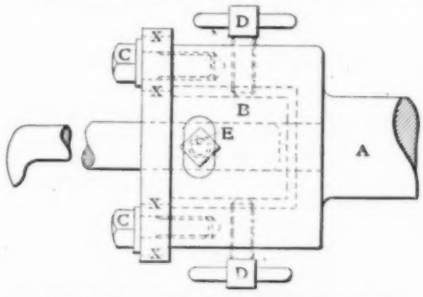
P. E. KLEINEBERG.

Croton Falls, N. Y.

Adjustable Boring Tool for the Turret Lathe

The accompanying illustration shows a simple chuck for adjusting boring tools in the turret lathe, which we have used for some time and which has proved very satisfactory.

The chuck consists of two pieces, the



ADJUSTABLE BORING TOOL FOR THE TURRET LATHE

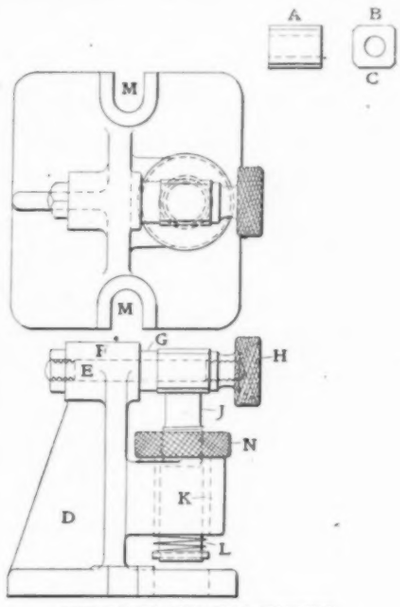
shank *A* and the adjustable holder *B*. The holder *B* is slotted as indicated by the lines *X X* and held to the shank *A* by the screws *C C*. On slightly loosening the screws *C C* a very fine adjustment may be had by the use of the screws *D D*, after which the screws *C C* are tightened again. The screw *E* is tapped into the holder *B* to hold the tool, and the shank *A* is slotted for this screw to allow the adjustment of *B*.

J. E. RITCHIE.

Detroit, Mich.

A Simple Grinding Fixture

The line cut shows a simple and efficient fixture designed for use on a Brown & Sharpe surface grinder. The piece to be ground is shown at *A*; it is a hardened-steel block requiring sides *B C* to be finished parallel and square with the hole. It was first attempted to thread a number



THE WORK AND THE FIXTURE

on an arbor and support on centers, using an ordinary indexing fixture; but the results were so unsatisfactory that the fixture shown was designed; and on trial the results were all that could be desired.

The fixture consists of a cast-iron base *D* with a hardened and ground pivot *E* pressed into the hole *F* and secured with a hex nut. The work is shown in position on this pilot, and is held up to the collar *G* by the nurled nut *H*. *J* is a hardened and ground plunger guided in a bushing *K* pressed into the base. This plunger is ground flat on the top and is raised up to the work by the nurled nut *N*, thus squaring the block and at the same time securing it from turning during grinding. A coil spring *L* is provided on the lower end of the plunger to insure withdrawal from the work. Bolt holes *M M* are provided in the base to secure to the machine table.

Marquette, Mich. S. W. MILLS.

Sulphur as a Lubricant

I have read your article on graphite and its lubricating qualities, but there are many places where it cannot be used, such as in flour mills, malt grinders, rubber works on grinders that are used for white stock, and other places.

What is the matter with sulphur for a hot box? It melts at 220 degrees Fahrenheit and reduces the temperature on brasses very rapidly. It puts a smooth surface on both journals and bearings. The only drawback is that it fills up the oil grooves.

Where possible the cap can be taken off and grooves cleaned out after the run is over; or if on a constant run, benzine will dissolve the sulphur and it can be washed out while running. Either kind of sulphur will do, the flowers or the stick. Probably the latent heat of the sulphur is what reduces the temperature so quickly.

Erie, Penn. A. N. HAMMOND.

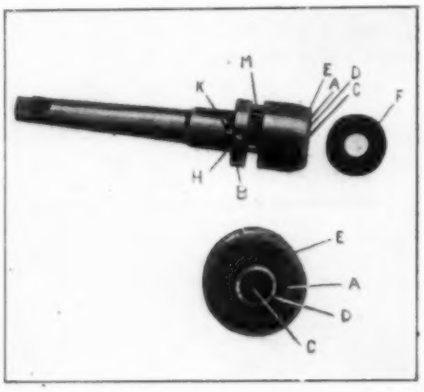
A Rubber Washer Cutter

There have been a number of articles in the AMERICAN MACHINIST lately relating to the cutting of rubber, and so I'll send one.

Fig. 1 shows the cutter which we use in a small drill press for cutting thin rubber washers. The rubber is about 1/32 inch thick and the washers are ¾ inch diameter.

The rubber is first wet and then placed on a hard board. The drill press is run at a good speed. As the spindle is raised, a stop strikes the ring *B* which is fastened to an inside washer and plug working inside the cutter. As the ring is pushed down by the stop, the cut rubber washer is pushed out and drops down. As the spindle is again brought down to cut, the rubber pushes up the ring. No springs of any kind are needed.

In Fig. 1 and the end view, Fig. 2, *D* and *E* are the cutting edges. *A* is the inside ring and *C* the inside plug. The



A RUBBER WASHER CUTTER

inside ring *A* is connected to the outside ring *B* by three pins, like *M*, working through drilled holes. The inside plug *C* is connected to the outside ring by the pin *H*, working through the slot *K*.

The shank and the cutting cylinders are turned out of one piece. *F* is a rubber washer cut with this cutter. This cutter does not dull easily, but when it does it is quickly ground on the universal grinder, using the internal grinding attachment for sharpening the smaller cutting cylinder

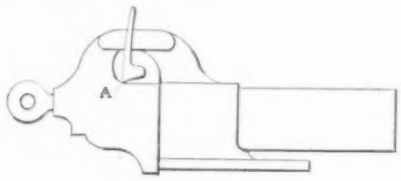
and an ordinary disk wheel for the outside.

Decatur, Ill. ETHAN VIALL.

A Vise Defect

I wish to mention a matter which many machinists seem to regard as a standing grievance. Most, if not all, machinists' vises are so constructed that a piece of work cannot be held between the jaws and rest squarely on the bottom at the same time. The trouble with the design of the vise is shown in the accompanying sketch.

While we know that the fillet at *A* is intended to strengthen that part of the



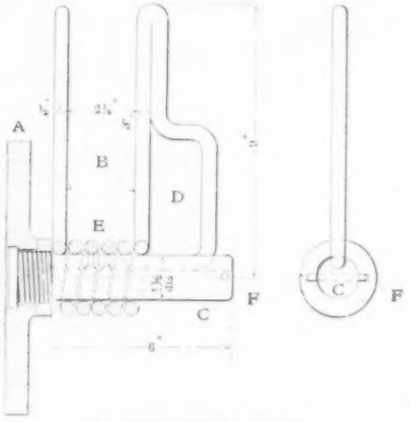
A DEFECT IN MANY VISES

vise, most mechanics would rather have the flat run up to a point in line with or a trifle beyond a line perpendicular with the face of the sliding jaw, thus enabling one to grip a piece of work between the jaws of the vise and at the same time allow the piece of work to rest fairly on the flat surface.

Bay City, Mich. G. H. WOOD

A Novel Belt Shifter

A belt shifter of somewhat unusual construction is shown in the accompanying figure. It consists of a single piece of ½-inch round iron rod wound around the pin *C*, bent to form the fork *B* and the



A NOVEL BELT SHIFTER

handle *D*. One end of the rod is bent inside the coil to form a guide, a groove being cut in the pin *C* to take it. This end is held firmly to the coils by the rivets *E*. A taper pin *F* acts as a stop. The whole is supported by a flange *A* bolted to a wall close to the machine to be driven.

Glasgow, Scotland. J. T. ALLEN.

Indexing a 5-Minute Vernier

Some time ago I had occasion to make a vernier reading to 5 minutes. As is well known, to do this it is necessary to make the distance between consecutive lines 55 minutes, or in other words divide 11 degrees in 12 parts. As extreme accuracy was not required, I decided to do the job on the milling machine, this being much quicker to set up than the dividing engine. To obtain 55-minute divisions the circle must be divided into $\frac{360}{11} \times 12$, or 392 8/11 parts. This is rather inconvenient, so I tried to leave off the 8/11. As this did not prove satisfactory, I tried another way. The extra 8/11 produced an error on a 5⅛-inch circle, the required diameter, of about 0.03 inch. For 11 degrees, the space covered by the vernier, this amounts to nearly 0.00125

INDEX PLATE FOR 5-MINUTE VERNIER

inch to be subtracted, if I used the index for 392. This looked good enough to try, and, compensating the error by moving the milling-machine table one-fourth of the 1¼ thousandths for every third division, I obtained a result good enough for the purpose. Theoretically every ¼ degree would be right, and the line next preceding should be out only 0.0002 inch. I doubt, however, if this was realized.

Recently the same thing had to be duplicated, so I decided to make once for all a special index plate for it. To index degrees on the dividing head, the index pin is moved 1/9 of a turn for every degree, 11 degrees being thus 11/9 of one turn. This must be divided in 12 parts, thus making each space 11/108 of one turn. To drill the plate, I mounted it on an arbor in the dividing head and indexed 4 turns and 2 holes on a 27-hole index plate. As will be noticed, after we have gone round once, the holes miss those already drilled by about one-fifth of a space, the hole corresponding to 50 minutes being that much beyond the zero; 55 and 60 occupy similar positions with regard to the 5 and 10 holes. To avoid confusion I stamped the minute figures inside until one turn was completed, and the remaining three outside the circle of holes.

Possibly somebody may find the method useful for other purposes. Obviously, where more than one turn is used, the limitation is that the holes must overlap enough not to run together. In this particular case, there was, if it had been necessary, room for enough holes to make 9 turns; in other words, an arc of 81 degrees could be divided in 55-minute spaces.

Washington, D. C. H. K. HARRING.

A Screw Clamp

The line cuts show a clamp for holding screws in a vise while filing or sawing them. The clamp consists of two plates

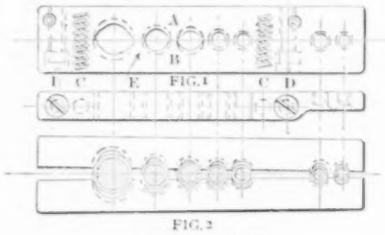


FIG. 1

FIG. 2

A SCREW CLAMP

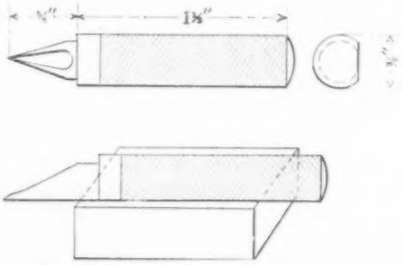
A and *B*, which are sprung apart by means of the springs *C* and held together by the screws *D*. The screws *D* let the plates open out just enough to allow the screws to drop through when the clamp is released from the vise.

Fig. 1 shows the clamp closed (1/64-inch packing is inserted between the plates while drilling and tapping them). Note that the clamp is filed away at *E* so that the screws will drop through with the least amount of opening of the clamp.

Bradford, England. F. P.

A Toolmaker's Scriber

This little tool has been found very handy for scribing lines where a surface gage would usually be used. It is some-



TOOLMAKERS' SCRIBER

times a difficult thing to set a gage as accurately as may be necessary or as you would wish to have it. By using this tool in connection with size blocks one can produce a line of great accuracy in much less time than would be consumed in setting a surface gage.

The tool itself is of tool steel, nurled and milled the entire length, as shown

in the illustration. After hardening, the flat surface can be finished with a cut or two on the surface grinder and then lapped, although this is not necessary, and it is doubtful if it improves the tool in the least.

In laying out models, templets or any sheet-metal work, the tool will be found very handy. Where size blocks are not to be had, anything of the proper thickness may be used, such, for example, as Woodruff keys, which I have used to advantage in connection with this tool.

GEO. F. MAC NARY.

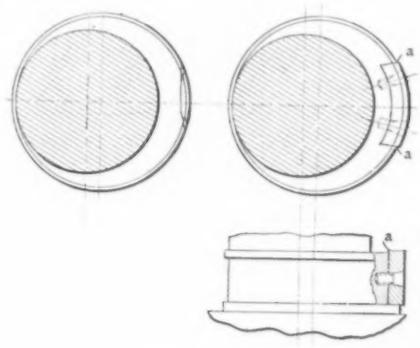
Bridgeport, Conn.

A Patched Eccentric

There are tricks in all trades, but can there be any that boast of more than that of the machinist? A little incident that happened in a Western machine shop may be interesting.

The product of this particular shop was heavy, steam road-working and agricultural machinery. We had turned out two large plowing engines, each weighing about 30 tons; as they were to be used across the Pacific ocean, it was desirable to have some extra parts to replace those most likely to get broken. Among these was a triple crank-shaft. The shaft was about four inches diameter, and, as usual, was made from a slab blocked out to form the cranks and twisted to suit. The six eccentrics were made solid with the cranks, and that was where the trouble came.

The first two came out all right; but when the extra one was nearly finished it was found to be "shy" in the eccentrics, two of which would not clean up. The time for the contract to be out had almost



A PATCHED ECCENTRIC

expired, and there was no time to get another forging, which was a rather expensive one; Thermit had not been invented yet, but save it we must some way. There seemed only one way to get at it with the equipment we had; that was to chip out the bad places and set in pieces. They decided that I could do the job as well as anyone, and thus I got some exercise of the "arm and hammer" brand.

The illustration shows where the eccentrics were deficient, and Fig. 3 how they were patched all around the place chipped out. I left a little ridge which was upset as shown at *a*; after this piece was fitted and screwed fast, the joint was calked. When the eccentrics were refinished, the joints could scarcely be noticed.

Cleveland, Ohio. C. HAMER.

Suggestion for a Shaper Tool Post

I had not run a shaper for some time until recently, when a turret lathe was being held up for want of a little planing on a tool holder; I took an idle shaper

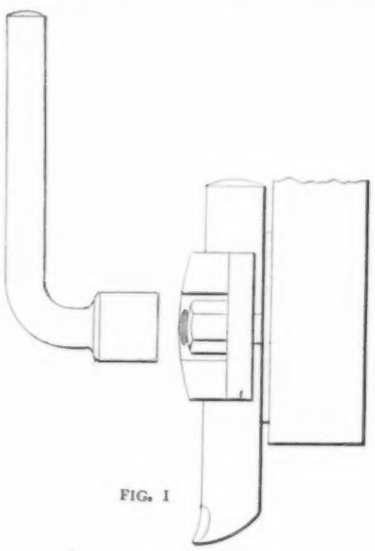


FIG. 1

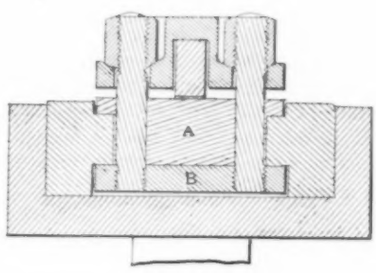


FIG. 2

SUGGESTED TOOL HOLDER FOR A SHAPER

and proceeded to do the job myself. The work required quite a little measuring and I had not been on the job two minutes before my opinion of the tool post with its projecting set-screw was not fit to print.

The time and patience consumed in stopping the machine (the ram kindly stopping at the outer end of the stroke every time), pulling it back by hand and then running the carriage over to one side to enable me to get at the work with an ordinary scale, compared to the touch of a dog and the quick run out of a planer platen, was awful for a man in a hurry.

This same thing is of course going on in the shops all over the world; the time thus wasted must foot up to a considerable amount in the course of a month, to say nothing of the nervous strain involved. As soon, however, as I tried to think of a better way to hold a tool firmly in a shaper, I found that it was not easy and that a cheaper way was impossible.

I inclose sketches showing my solution of this problem and think that it will undoubtedly hold a tool firmly and enable it to be turned at all angles, besides avoiding at the same time any considerable projection of post or screw. It will also cost a dollar or so more to make in a satisfactory manner. If someone will think of a better plan than this and get it used, he will help impatient machinists and the boss.

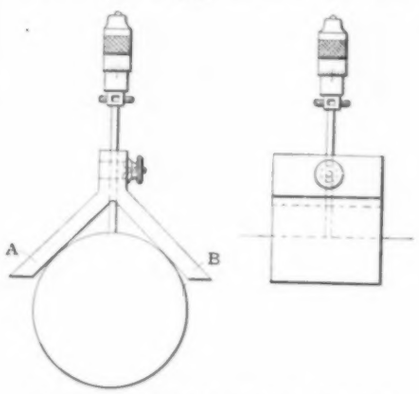
Croton, N. Y. T. A. SPARKS.

Another Holder for the Inside Micrometer

At page 806, Vol. 30, Part 2, there is an article by Q. Wood on laying out and boring jigs. He makes mention of a special holder for the Starrett inside micrometer. The device is very good for surface-plate work and to measure from plane surfaces. To measure between two cylindrical bodies or from a cylinder to a plane surface is a different proposition.

The sketch shows a device which I have used on horizontal boring mills to measure between bars and in erecting of machines, to get the alinement of shafts and screws. To measure between two shafts or bars, take the distance between centers, deduct from this the sum of half the diameter of both the shafts or bars, and set the micrometer to this measurement. Place the gage on either bar, letting the end of the stem touch the bar and then tighten up the nut.

Assuming the gage to be made accur-



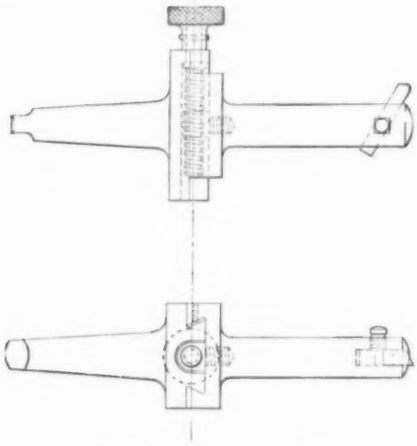
SPECIAL HOLDER FOR STARRETT INSIDE MICROMETER

ately, the micrometer will stand in a true radial line from the center of the shaft and at right angles with the center line of the shaft, giving a true measurement. Any difference from the required measurement can be readily seen by the micrometer, making it much superior to a fixed gage. When used on a plane surface, the gage rests on the flats *A B*. I have likewise used this in connection with a Starrett dial indicator.

Philadelphia, Penn. A. N. PACK.

A Handy Boring Bar

The cut illustrates a very convenient boring and facing bar. The shank can be made to fit a milling machine, drill press or a horizontal boring mill. This one was made for use on jig work in the tool room and was fitted to the spindle of a No. 3 Brown & Sharpe milling machine.



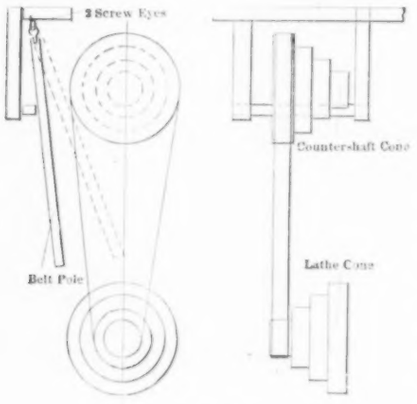
BORING AND FACING BAR

It has proved itself a very efficient all-around tool, useful for many purposes such as counterboring holes, facing both sides of a piece after the hole is bored, boring recesses, etc. It also affords a better method of adjusting the tool than the usual tap of the hammer.

Troy, N. Y. T. DEWITT.

A Belt Pole

The line cut shows a belt pole that I found in a shop some years ago. It is always just where it is wanted. It is hung just behind the large step on the countershaft cone, with two screw-eyes



A BELT POLE

linked together. The one is screwed in the end of the pole, the other in the timber that the countershaft hanger is fastened to. A bracket is put up for the pole to lie against to keep it in a handy position.

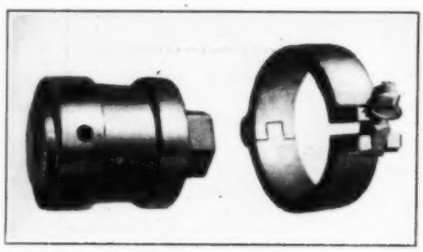
Fort Wayne, Ind. D. H. SMITH.

Turning Piston Rings

I have been much interested in the articles which from time to time have appeared in the AMERICAN MACHINIST regarding the methods of finishing piston rings. All seem to agree that the ring should be turned after it is split, and the many appliances used for this purpose, if compared, would show great similarity of construction.

The article by Geo. Scott, on page 600, was particularly interesting to me, because, judging from his sketch, he must have experienced the same trouble as some others of us in removing the sleeve from the rings, and had devised the jack screw to overcome the difficulty.

The accompanying photograph shows a jig which is being successfully used. It consists of the usual chuck fitted to the lathe spindle and turned with enough eccentricity to give the rings the required form, with a collar and nut to clamp them



TURNING PISTON RINGS

in position, and a sleeve to hold them while being clamped.

The feature of this jig is the sleeve, which is hinged so that when the rings are secured in position the operator has merely to loosen the nut, swing out the bolt, quickly open and remove the sleeve, and proceed with the operation of turning the rings.

Groton, N. Y. W. C. CHINNECK.

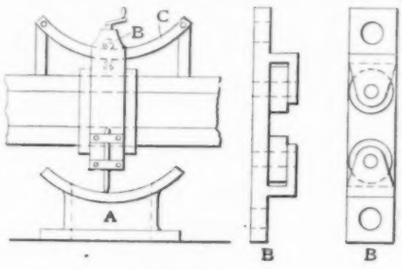
Rolled-thread Taps

While the rolling of threads in taps may produce a smoother thread than any E. A. Dixie has seen cut with a tool I do not believe it is possible to make an accurate tap in that way. The preliminary cutting of the thread reduces the distortion of the metal but those who are experienced in this line agree that it is not possible to force metal in this way, especially tool steel, without detriment to its structure. Neither do they believe that you can depend on securing identical results with different pieces of steel so that taps made in this way are almost sure to vary. It may be that they answer very well for ordinary work if care is taken, but I very much doubt that really accurate or uniform taps can be produced in this way. Neither do I believe the taps are enough cheaper to warrant the fitting up for such a process.

Springfield, Mass. I. B. RICH.

Planing Saddle Pieces to the Arc of a Circle

The piece shown at *A* in the line cut is machined on a planer in the manner shown. The screw feed for the tool is taken out and a bracket *B* is secured to the back of the tool slide. This bracket



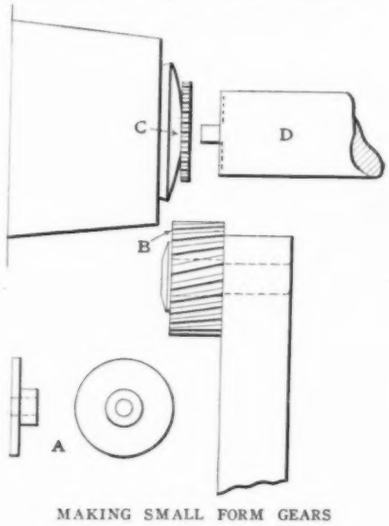
PLANING ARCS

carries two rollers, as shown. A former *C* is secured to the cross rail of the planer, as shown. The two rollers touch the former, one on either side, top and bottom. The job is started at one side and the tool is fed across in the usual way by the cross-feed screw. It takes about the same time to machine one of these pieces as it does to machine a plain flat piece of work. The rig is applied or removed in about five minutes. Care must be taken to have the casting and former in line.

New York. E. A. DIXIE.

Making Small Worm Gears

A large quantity of small worm gears was required for a certain job; they were five-eighths inch pitch diameter, one-six-



MAKING SMALL FORM GEARS

teenth inch face, 20 teeth, 32 pitch, with a hub on one side as shown at *A*. The blanks were made in a turret lathe and the teeth formed in a punch press by forcing the blanks through a die; after this operation the teeth were left straight.

A small helical gear *B*, of 21 teeth and having the angle of tooth the same as that required in the worm gear, was made

from tool steel and hardened. This was mounted on a shank and held in the tool post. The blank was held in a draw chuck *C* by the hub; a mandrel *D*, with a short guide to fit the hole, was held up against the outside by the tailstock.

The blank was rotated at a fairly good speed and the nurl *B* brought into mesh with it gradually until the pitch lines were coincident. A slight bur, left by the punching and nurling, was removed with a file and a passably good job obtained at a comparatively small cost.

Marquette, Mich. E. C. O.

The Omission of Claims in the Patent Office Gazette

The editorial on the *Gazette* of the United States Patent Office on page 30 was timely.

The *Gazette* is of value because we can (or could) get from it a quick and more or less complete knowledge of the essential features of any patent that issues. It also serves as an index of all patents that issue. The British Patent Office, through their classified abridgements, give a condensed description of the invention of each patent. This is more valuable than the mere printing of the claims, as the claims often contain such words as, "means for" doing so and so, and without seeing the specification it is sometimes difficult to tell what the means are. However, the increased force necessary for our Patent Office to get out such abridgments as the British office prints would cause Congress to throw up its hands in horror. The printing of the claims is merely a matter of word for word copying from the records. It would seem that this was the least that could be done; but we evidently figured without our host. In one of the recent *Gazettes* I saw at the end of the fifth claim of a patent the words "Claims 6 to 167 not printed in the *Gazette*." The printing of the first five claims and the omitting of all the others might have some small amount of excuse on the ground of economy if there was an accompanying rule that an applicant must place his broadest claims in the first five; but, without such a rule, the sixth or the one-hundredth claim may be more important than any of the first five. The saving in printing to the office is apparent if one compares a recent *Gazette* with one before the change was made. The number of pages is about one hundred less than before.

The *Gazette* should also show the class and sub-class in which each patent is classified. This would enable one to roughly search the patents relating to any one field without having to go to the expense of ordering the patents or going to Washington. It would also make it easier for one to look in each *Gazette* as it comes, for the patents in any class in which he is particularly interested. This should particularly be done in the monthly volumes of specifications and should be accompanied by a classified index, as they have in English, German, French, and other Patent Offices where these things are done better than they are in this country.

Now the thing to do with such a matter as the *Gazette* is not to simply remark upon it, but everyone who is inconvenienced thereby should write to the Commissioner of Patents stating the reasons why he thinks such a change is not to the benefit of the users of the *Gazette*.

To get down to the real trouble, the office is always hard up. It has to save money from somewhere in order to keep within its appropriation. The commissioner, no doubt, does not make such a change as has occurred in the *Gazette* except under great necessity. The Patent Office is in the position of a corporation whose stockholders (Congress) like fat dividends and therefore do not like to put any money into the business.

If one looks back over the reports of the various commissioners he finds one after another urging the necessity for more room, more help, better facilities, etc., etc. If these things were only thought necessary by one commissioner one might think that it was only his whim, but being urged year after year by every man who serves in the position seem to make the proof strong. No respectable business concern would ever dream of trying to do the amount of work which the Patent Office is obliged to turn out under any such conditions as exist therein. One commissioner in his annual report gave a table showing the amount of air per occupant in the various examining rooms, and proved that in comparison with the amount of air which the best authorities considered necessary it was not only ridiculously low, but dangerously so. There is no room for storage of copies of patents, or of the priceless old models which so narrowly escaped being destroyed a few years ago simply to make more room and save the expense of storage.

As Commissioner Allen said in his report last year, the five or six million dollars to the credit of the Patent Office in the United States Treasury should be used to erect an appropriate building for the sole use of the office.

The manufacturers, attorneys, inventors, and all who are interested in the welfare of the Patent Office can help toward obtaining for it the things which it should have, by taking the matter up with their Congressmen. Explain to them and urge upon them the justice of giving the Patent Office the consideration due it. Bring such pressure to bear especially during the time that the Patent Office appropriation bill is in Congress.

Lowell, Mass. IRVING D. KIMBALL.

[Several letters from large manufacturing firms have reached this office referring to the editorial on the omission of claims from the *Gazette*, and agreeing with the position taken that it is an unfortunate and deplorable change. It is hoped that action may be taken by manufacturing and other interests to cause a return to the former method of including all of the claims before so many issues of the *Gazette* shall have been printed as to make an appreciable gap in the records.—ED.]

Cutting Speeds of the New Steels

The German Society of Engineers having requested the well known Prof. Hermann Fischer, of the Technical High School in Hannover to make a report upon the new "rapid-cutting" steels, he circularized the members of that society, with a view to getting an average opinion, based on actual experience, as to the proper cutting speeds on machine tools able to do the work that the tools would stand. The following figures show the speeds given by various members for roughing on lathes strong enough to stand up to the strain. The figures given in the professor's report are in meters per minute; I have changed then into feet per minute, as being more convenient to the readers of this periodical.

ROBERT GRIMSHAW.

Dresden, Germany.

Suggested By.	Cast Iron.		Wrought Iron and Steel of 56,890—64,000 Lb. per Sq.In. Tensile Str.	Steel of 85,340—99,560 Lb. per Sq.In. Tensile Str.	Steel Castings.	
	Soft.	Hard.				
3	82.0—98.4	49.2—65.6	131.2—164.0	65.6—82.0	39.3—49.2	13.1—19.7 Nickel Steel.
1	39.3—49.2	37.3—49.2	49.2—59.1	26.2—32.8	39.3—49.2	
2	39.3—49.2	26.2—32.8	49.2—59.1	32.8	39.3	
4	.....	.....	49.2—59.1	39.3—49.2	.....	27.9 for steel, 99,560 to 11,380 lb. tensile str.
5	23.0	19.7	59.1	49.2	19.7—26.2	
6	.....	.....	.....	75.4—39.4	.....	
7	.....	.....	.....	32.8—49.2	.....	
15	39.4—45.9	39.4—45.9	39.4—45.9	39.4—45.9	39.4—45.9	39.4—45.9
Average..	49.2—65.6	39.3—49.2	65.6—98.4	49.2—65.6	39.3—49.2	

CUTTING SPEEDS OF ROUGHING LATHES—FEET PER MINUTE.

Two things will contribute toward success, your own intelligence and persistency; forget about what your fellow worker is doing.

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Feb. 6..... 35,750

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None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation.

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Success as a Test of Reliability

In a paper presented at the December meeting of the American Society of Mechanical Engineers by Sydney A. Reeve, on the "Evolution of the Internal Combustion Engine," occurs this paragraph: "Yet even among several types of steam engines it has never been the most efficient design which has succeeded most markedly. The winning considerations in the steam-engine field are those of capacity for power in terms of space and weight, reliability and controllability or adaptability, coupled with reasonable efficiency. Of course, other things being the same, a more efficient has always been preferred to a less efficient engine; the greater efficiency has nearly always been accompanied by a difference in those other things; reliability and adaptability have not been so great; and the competition has always been reduced, in the long run, to those other considerations."

This quotation sets forth clearly the part which the elements of reliability and adaptability have played in successful engine design. These two factors have entered to as great a degree into the operation of successful machines in general. It is not merely the machine which can perform complicated operations and turn out its product, but it is the machine which can do these things to a reasonable extent, and at the same time keep doing them day after day with a minimum of shut-downs for adjustments or repairs, or changes from one class of work to another which is able to hold the field against competitors.

Some machines have had almost a phenomenal success, and there are some whose inventors fashioned them so wisely that they are used today in practically the same form in which they were left by the original designs. Among these might be mentioned the automatic screw machine known as the Spencer patent. This type of machine has been produced in great numbers over a period of many years, and is even now being produced essentially the same in principle as when originally developed by Mr. Spencer. A second illustration is the first machine successfully developed for sewing shoes, known as the "McKay Sewer." While this type has been in use for a great many years, and for a long period of time the bulk of the shoes produced in this country were made upon it, yet even today it is manufactured and used in practically the same form in which it was originally built. Both of these machines possess the elements of reliability and adaptability and have earned a well merited success.

Too many devices and appliances are made which have elements of ingenuity, or better misdirected ingenuity, and little else. The familiar term "trappy" is truly descriptive of such productions. In general they are short-lived, because they are so constructed that they cannot perform the functions for which they were designed continuously and therefore successfully. There is a common saying to the effect that an ounce of loyalty is worth a pound of cleverness. This thought might be restated as applied to machines as: An ounce of reliability is worth a pound of ingenuity.

A Valuable Addition to the A. S. M. E. Library

The American Society of Mechanical Engineers is to be congratulated on the splendid addition to its library through the generosity of one of its best known members, Henry R. Towne. Some of the volumes date back to 1801 and the majority of them were printed previous to 1865, making it a notable collection of historical books, which oftentime contain more of value than we are apt to think and which would save us many thousand dollars in experiments if we but heeded their teachings.

One of the most notable examples of this is the book of C. Wye Williams on "Combustion of Coals," published in 1841, in which will be found all necessary details of a large number of tests which must have required endless patience and almost tireless energy, and which show practically every form of combustion improver and smoke consumer which has since been "invented" and used. It would be difficult to say how many thousand dollars of worthless experiments might have been saved had this book been studied first, but it would easily make a fortune that would satisfy most of us.

In the list published in the January *Proceedings* of the society, we find many notable books such as, "Evans on Steam," "The Locomotive Engine," by De Pambour; "Papers on Iron and Steel," by Mushet; "Combustion of Coals," by C. W. Williams; "Indicator and Dynamometer," by T. J. Main and Thos. Brown; "Cast and Wrought Iron," by William Fairbairn; "European Railways," by Colburn and Holley; "Papers on Mechanical Subjects," by Joseph Whitworth; "Engineering Precedents and Steam Engineering," by Isherwood, and "American and European Railway Practice," by Holley, with others, which are also valuable though perhaps not as well known in the mechanical world.

Collections of this kind are, or should be, safer in the care of such a library as this than in most private houses and we believe it is better for the owner as well as for the engineering public to have them cared for in this way. Any of us who have a few choice books, however, realize a hesitancy to part with them and Mr. Towne is to be commended for the generous spirit and broadness of view

which prompted the donation. We feel that by this action he has placed us all in his debt.

For a Tariff Commission

The membership of the National Association of Manufacturers, by letter ballot, have almost unanimously voted to advocate a "National, Permanent, Non-Partisan Expert Tariff Commission."

A bill to establish such a commission has been introduced into Congress by Senator Beveridge, which provides among other things that: "The composition of the commission shall be as nearly as possible as follows: First, one member identified with the producing interests; second, one member a lawyer who has made a special study of the customs and tariff laws of the United States; third, one member who has had special experience in connection with the administration of customs and tariff laws of the United States; fourth, one member familiar with industrial and commercial conditions in foreign countries affecting competition of foreign products with products of the United States and thoroughly conversant with the customs and tariff laws of those countries; fifth, one economist and statistician who has given special attention to the subject of prices and cost of production as affecting the tariff. No member shall belong to either branch of Congress. The members of said Commission shall be appointed for terms of seven years, but any Commissioner may be removed by the president for inefficiency, neglect of duty, or malfeasance in office."

The commission will have no very great authority but will be authorized to give expert counsel and advice when the tariff question is up in Congress. The bill provides: "That it shall be the duty of said commission to investigate immediately the cost of production of all articles covered by the tariff, with special reference to the prices paid American labor in comparison with the prices paid foreign labor, the prices of raw materials, whether domestic or imported, entering into manufactured articles, the condition of domestic and foreign markets as affecting American products, and all other facts which, in the judgment of said commission, may be necessary or helpful to Congress in providing equitable rates of duties on any article; and, in general, to thoroughly investigate all the various questions relating to the manufacturing, agricultural, commercial, and mining interests of the United States so far as the same may be necessary or helpful to Congress in enacting customs tariff laws."

Such a commission ought to save a great deal of stump speaking in and out of Congress.

When the tariff question was up the commission would have on tap the facts and figures that would let Congress go to work and change the schedule intelligently, instead of smoking the ceilings with hot air.

Such a commission would stop the disturbance to business caused by a general tariff discussion and a political campaign on that issue.

It would be something in the nature of a court sitting to conduct a hearing and weigh evidence for and against.

The manufacturers of machine tools are becoming more and more liberal in their tariff views, so far as it concerns their own product. There are practically no machine tools imported, and millions of dollars worth exported.

Our 45 per cent. duty produces no revenue at home and has caused retaliatory tariffs in European countries. Free trade in machine tools would be a good thing for American machine-tool makers, but they can't have it, because the "union" won't let them. The "union" is the other protected interests.

If we were making machine tools and hoped in time to establish some foreign trade we should sit down, right now, and write our Senator and Congressman asking them to support the Beveridge bill to establish this commission.

It would be worth all it cost to get some reliable non-partisan data whether we decide to take down the wall, build it higher, or just to sit in the shade.

New Publications

The American School of Correspondence, of Chicago, has brought out a series of practical manuals for working men of which we give notices of four on Tool Making, Machine Shop Work, Mechanical Drawing and Patternmaking below.

MACHINE SHOP WORK. By F. W. Turner. 185 6½x9½-in. pages, with 241 illustrations. Price, $1.50.

This is an eminently satisfactory book for the apprentice boy or the student just beginning his course in machine-shop work, but is too elementary to be of much value to the experienced mechanic. It is full of real instruction, without that-pat-you-on-the-back style which some authors consider appropriate for books of this nature.

MECHANICAL DRAWING. By Ervin Kenison, 142 6½x9½-in. pages with 99 text cuts and 15 full page plates. Price, $1.

This book does not take up machine drawing but confines itself to geometrical problems, projections, intersections, developments, lettering, etc. The subjects treated are, of course, essential preliminary to the taking up of machine drawing and are well treated and illustrated, while the price is low considering the extent of the ground covered.

PATTERNMAKING. By James Ritchey, 141 6½x9½-in. pages with 254 illustrations. Price, $1.

This will be found an excellent book for the apprentice patternmaker. It does not, of course, take up difficult pattern work but it includes a good many representative pieces as is proper for the beginner. An excellent feature is a chapter on methods of molding whereby the apprentice is put in touch with the more common operations of the foundry and thus made to understand the leading requirements of his own work in a manner which is essential to the patternmaker.

TOOL MAKING. By E. R. Markham. 206 6½x9½-in. pages, with 327 illustrations. Price, $1.50.

The chapter headings of Mr. Markham's book are: General Principles of Tool Making and Metallurgy; Drills, Reamers and Taps; Dies and Forming Tools; Work-holding, Guiding and Gaging Tools. So far as the descriptions of actual tool-room methods are concerned, the experienced tool-maker will find the book somewhat elementary, although full of helpful hints and suggestions. Its elementary character will, however, be found to adapt it especially for the beginner in tool-making, for whom, we presume, it was especially intended.

Personal

Willis G. Young, previously employed with the Postal Vending Manufacturing Company, Sedalia, Mo., has been appointed mechanical engineer and instructor of the O. S. and S. O. Home, at Xenia, Ohio.

Messrs. Knight and Pidding, of the firm of Charles Churchill & Company, London, England, sailed for America on January 21. They come in search of information concerning new goods and general conditions.

Charles E. Ward, who has been connected with the Ward's Engineering Works, of Charleston, W. Va., as superintendent for a number of years, has recently organized and become president and general manager of the Charles Ward Engineering Works, with headquarters at Charleston.

Dwight S. Cole, formerly designer with the Olds Motor Works, is now filling a similar position with the Drake American Steam Turbine Company, Grand Rapids, Mich. Mr. Cole is at present engaged in assisting in the development of the multi-stage impulse steam turbine under Charles W. Drake's patents.

William V. Lowe has recently associated himself with the Hess-Bright Manufacturing Company, Philadelphia, Penn. He will principally occupy his time in looking after the ball-bearing end of the automobile industry in New England and vicinity. Mr. Lowe has been connected with the industry some time, having been chief draftsman of the E. R. Thomas Company, and subsequently acting as chief engineer with the F. A. Brownell Motor Company.

New Tools and Machine Shop Appliances

Showing New Ideas in Machine Shop Equipment That Make It Possible To Do Better Work at a Reduced Cost

THE LATEST INFORMATION

Profile Steel

Two high-grade tool steels of English manufacture, one an air-hardening quality, the other a water-hardening quality, rolled to special shapes for tools, have recently been put on the market in this country by the New Metal Tool Steel Company, with headquarters at Portland, Me., and a branch at 95 Cliff street, New York City. These special-shaped steels are known as "profile steels." Eight of them are shown in section by Fig. 1, and the accompanying names are fairly descriptive. Some 250 different sizes are carried in stock, among which are 18 fluted sections, *A* of Fig. 1, 24 V-sections, 55 star sections, 25 three-wing sections, 3 scraper sections, and others.

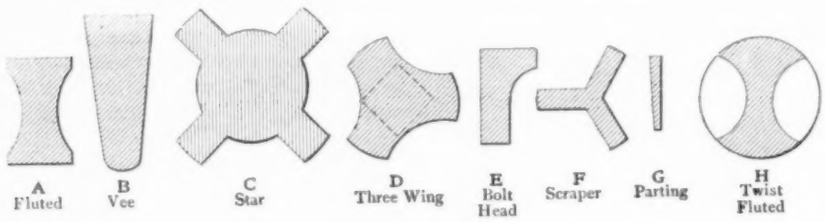


FIG. 1. SECTIONS OF PROFILE STEEL

The striking feature of these shapes is the saving in weight of a bar necessary to produce a given tool as compared with the sizes in rounds, squares and flats which would ordinarily be used. To illustrate, the fluted profile averages in weight only 35 per cent. of the weight of a square bar which would be selected for the same kind of a tool. Similarly, the V-section weighs only 32 per cent. of the weight of a square bar of the same depth. The star profile averages in weight 57 per cent. of a round bar and 43 per cent. of a square bar of the same general dimensions.

Adaptation of the Profiles

The profile shapes *A* and *B* of Fig. 1 are rolled for cutting tools for the lathe, planer and shaper. In using the profile on English machine tools, blocks are made to fit the outline of the V and thus form a rigid fastening on the tool blocks. A similar arrangement would, of course, be necessary with the American tool post. The star profile has been developed for counterbores, and in the larger sizes for milling cutters, profiling tools, etc. In addition to the saving in stock, there is the saving in the labor necessary to mill the flutes from the solid. The three-wing section, *D* of Fig. 1, is for roughing reamers and three-lipped chucking drills. The next section, profile *E*, is known as the bolt-head section and has been developed for turret-lathe work. It is made in a variety of special shapes to conform to the ordinary types of bolt heads, and is intended to be used on the rear of the turret lathe cross-slide. Profile *F* is for scraping tools and profile *H* for cutting-off tools.

The last profile which we show in Fig. 1, designated by the letter *H*, is of particular interest. It is known as the twist-fluted profile and is used for twist drills. As this section can be bought in the bar and can be cut off to any length desired it is of a special use in making odd-length drills. It can be used for straight-shank drills or, if desired, the shank can be turned to some standard taper to fit taper collets. Drills of a special diameter can be made by using stock slightly larger than the diameter needed, and turning or grinding it to size.

Fig. 2 shows a few tools made from some of these profile shapes. The counterbore and three-lipped reamer or drill needs no mention. Below them are shown two drills made from the twist-fluted section; one has a taper shank and the other a straight shank. The bushing shown between the two drills is intended to adapt a taper shank to an ordinary chuck. It is made of steel of a spring temper, has a taper hole to fit the shank, a slot in one end into which the tang of drill fits and is split along one side so as to spring when gripped by the chuck.

The Steel

These profiles are rolled by the Baltic Steel Works, Sheffield, England, and it may be of interest to speak of one or two points in their manufacture. One point that has been urged against some high-speed steels is the question of lack of uniformity between bars of the same brand. One reason which has been advanced for this lack of uniformity has been the character of the metal used to produce the special alloy. For instance, tungsten is heavy and has a tendency to settle to the bottom of the mold when the steel is in a molten condition, and thus

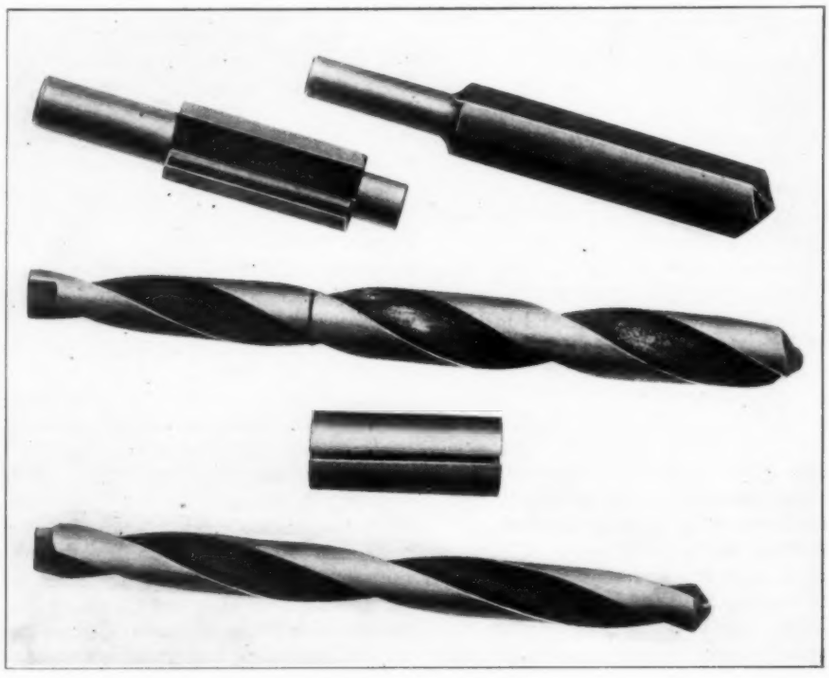


FIG. 2. TOOLS FROM PROFILE STEEL

produce a mixture throughout the ingot containing varying qualities of this special alloy and thereby producing tools which will give varying results. Recognizing this fact, the makers of the high-speed steel used in these special profiles and in the squares, flats and rounds of the same grade, cast their ingots in molds which are revolved during the process of cooling, to overcome the tendency of the alloy to settle to the bottom. The melting of the ingredients for this special steel is done entirely in an electric furnace, which allows of a higher temperature than that which is ordinarily obtained.

As the special profiles have a greater surface compared with their volume than ordinary bars of flats, squares and rounds, it is easier to obtain uniform and even annealing. This is an important point in dealing with high-speed steel.

These steels have been subjected to extensive tests at the Sheffield Testing Works. While it is unnecessary to treat in detail of results which were obtained, still their standard specifications and methods of testing such steel is of interest. They require a cutting test of 20 minutes' duration at a speed of 40 feet per minute, a depth of cut of 3/16 of an inch and a feed per revolution of 1/16 of an inch, thus giving a total weight of metal removed of 32.8 pounds or 1.64 pounds per minute. This test is run entirely without lubricants, and upon a bar of hard steel of the following composition: Carbon, 0.68; silicon, 0.136; sulphur, 0.052; phosphorus, 0.055, and manganese, 0.63 per cent. They state that it is only a very good high-speed steel tool that will stand this 20 minutes' test under these conditions.

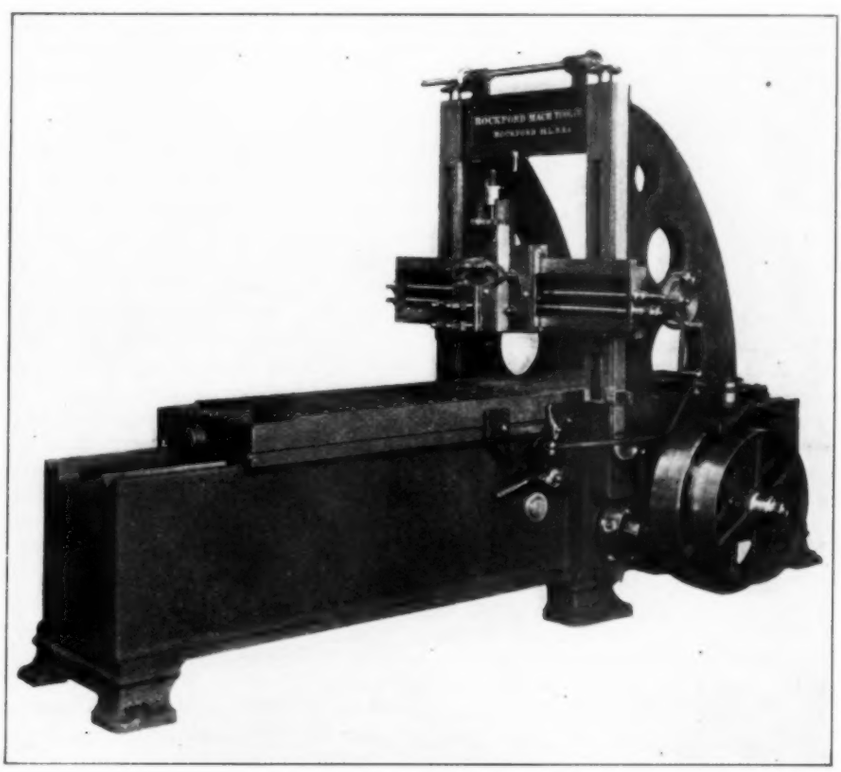
A 24-inch Planer

The illustration shows a 24-in.x24-in.x 6-foot planer, the first of a line of heavy pattern metal planers being brought out by the Rockford Machine Tool Company, Rockford, Ill. All bearings in the bed are bored, bushed and fitted with self-oiling devices.

All the gears in the drive are on the inside of the bed; twin pinions on the pulley shaft and twin gears on the master gear shaft, one on either side.

The planer shown weighs 7100 pounds. The platen at a cutting speed of 30 feet per minute has a return of 95 feet per minute.

The feed range is from 0.016 to .750 inch.



A 24-INCH PLANER

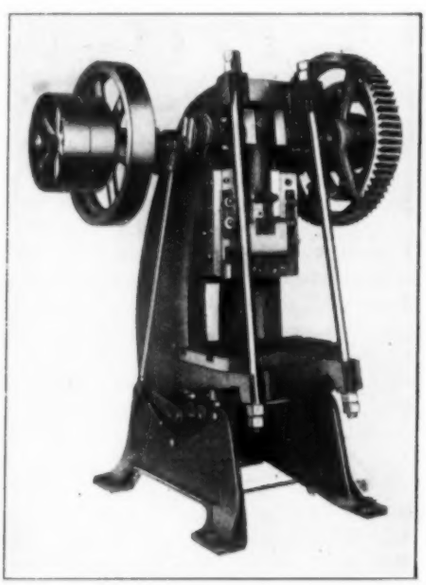
A Lock Nut

The illustrations show a lock nut which comprises two parts, one part having a cam-shaped recess into which the cam-shaped projection of the other part fits. When the nut is screwed up as far as desired, the one member is held with a wrench while the other is turned, the cam faces forcing the split portion of the other member to grip the thread. To take the nut off the process is reversed. This nut is manufactured by the Wm. M. Howard Company, Inc., The Bourse, Philadelphia, Penn.

A LOCK NUT

A Punch Press

This press is specially adapted for operating tools for heavy punching, forming, cutting and stamping and covers a wide range and variety of work. By having a belt rim bolted on the gear wheel it is possible in a couple of minutes to change the press over from fly-wheel to geared or *vice versa*. The press has positive top and bottom knockouts, the top of punch knockout being of the cross-



A PUNCH PRESS

bar type easily adjusted for the different hights of dies and punches to be operated; while the bottom knockout is operated by means of a crank on the end of shaft through the connecting rod on the side of the press, which connects with a lever fastened on the bottom knockout shaft; this bottom knockout is readily adjustable; the tie rods add strength and rigidity to the press. The press as shown weighs, approximately 7700 pounds, and is built by the E. W. Bliss Company, 1 Adams street, Brooklyn, N. Y.

An All Metal Shop Stool

This stool combines a practically unbreakable construction with low cost. The legs are of 1 inch angle iron; the pressed steel top of 16 gage steel; the rungs of bessemer and it is fastened together with extra heavy rivets, the rungs being butted against the angle iron legs. This stool has

AN ALL METAL SHOP STOOL

a back consisting of angle iron with pressed steel support strongly attached thereto, all the stools being arranged for use with or without backs. The stools are manufactured in hights varying from 18 to 30 inches by the Manufacturing Equipment and Engineering Company, Boston, Massachusetts.

Reports from France indicate that the productive capacity of the French motor industry has considerably exceeded the market for French machines. Ordinarily this would result in a decided effort to sell more machines in the United States, but the success of the industry in the United States and the fact that there appears to be more American cars sold abroad, together with the duty of 45 per cent. on motor cars entering the United States naturally offset the tendency of foreign manufacturers to cultivate the American market to a greater extent.

The First Annual Meeting of the National Society for the Promotion of Industrial Education

The meeting of this society, held at Chicago, January 23, 24 and 25, was a noteworthy event. That any distinct steps toward the establishment of trade schools were taken cannot be claimed, but the meeting was well worth holding, if only as a demonstration of the hold which this movement has suddenly taken upon the American people. So far as individual papers are concerned, some were wordy, and others extremely amateurish, but the spirit and go of the meeting were unmistakable, the convention hall of the Art Institute being well filled morning, afternoon and evening. Considering that the society is but one year old, the results accomplished are indeed remarkable and all that could have been expected or hoped for by the most optimistic. Because of the discursive nature of many of the papers, no attempt will be made to report them all, even in outline, this report being limited to a statement of the more important facts and opinions expressed.

The proceedings were opened with a public dinner at the Auditorium hotel, which was presided over by Theodore W. Robinson, first vice-president of the Illinois Steel Company, and chairman of the Illinois State committee of the society. The first speaker at the dinner was Dr. Charles W. Elliot, president of Harvard University, whose address was a remarkable illustration of the new views of education and of the educational needs of the country, which has forced its recognition upon the professional educator, and as an opinion was doubly remarkable from a man of Dr. Elliot's age and scholastic training. He planted himself squarely upon the platform of State-supported trade schools and compulsory attendance thereon. He was followed by James W. Van Cleave, president of the National Association of Manufacturers, who voiced much the same opinion.

Mr. Van Cleave was followed by Dr. Henry S. Pritchett, president of the society, who outlined its objects, saying that the first is to arouse the American people to the fact that they are behind the rest of the world in all that pertains to industrial education. He contrasted Berlin with Chicago, saying that they had about the same population, but that whereas in the former city 55 per cent. of the boys between 14 and 16 years of age are in continuation schools, in the latter, the number in such schools is negligible. He outlined the work of the society during its first year, and stated that it had now reached a point justifying the appointment of a permanent salaried commissioner to devote all of his time and attention to the work. He hoped that within the next year the society would be able to recommend a definite line of action and concluded by a really eloquent peroration, in which he declared this to be but a part of the great problem of democracy, in justifying itself by its results.

The first regular session of Friday morning was opened by Carroll D. Wright, president of Clark College, who referred to the development of modern apprenticeship systems, saying that the audience would be surprised if they knew facts. He was followed by W. R. Warner, who corroborated this statement and combatted vigorously the popular impression that the apprenticeship system is dead. He believed that there are more apprentices in the iron trades today than ever before.

Mr. Warner was followed by W. B. Prescott, an official of the typographical union, who gave one of the most important and interesting addresses of the entire convention. He outlined industrial conditions from the workman's standpoint, saying that the present factory system introduces a race of job hunters. The principal portion of his address was devoted to a description of the efforts of the typographical union to introduce instruction in high-class work in the printers' trade. This has been done because the great sub-division of labor now followed makes effective apprenticeship to the entire trade impossible, and this condition, he pointed out, is now common in many other trades. He referred feelingly to the monotony of the work which follows its minute subdivision, and of the need of trade schools, in order to provide that information which would give a living interest to a workman's work. The main question from the workingman's standpoint was said to be whether these schools are to benefit or exploit him. He did not consider the present need to be so much for more workmen, as for greater individual skill. He believed the reasons which keep boys out of factories to be the humiliating conditions which surround factory work and the social ostracism that goes with soiled clothes and horny hands.

Mr. Prescott was followed by J. F. Deems, general superintendent of motive power of the New York Central lines, who outlined the system of apprenticeship and of apprenticeship schools, which has been inaugurated by the railroad with which he is connected. The object of this course of instruction is to provide men from whom shall be selected the entire official mechanical force of the road. He considered it essential that the work of such an apprentice school should be done in the day time, and considered it unreasonable to expect boys to attend school evenings after their shop work is over. About 500 apprentices are now working

under the system in ten shops of the company, the net results being very beneficial to the company, due largely to a fact that a much better class of boys are now being attracted to the shops than formerly.

Leslie W. Miller, principal of the Pennsylvania School of Industrial Art, combatted the idea that the learning of a trade is essentially different now from what it has always been. The method is simply to go to work in shops and learn how to do things from those who already know. While the terms and conditions may change, this has always been in the way and it is indeed the only possible way. He had no faith in manual training.

The later sessions were occupied more largely by professional educators, whose papers were chiefly of interest, as showing that the educator has awakened to the fact that the present school system is entirely inadequate to the needs of the country. The fact that but 4 per cent. of the boys of the country pass through the high schools and that the vast majority leave school for good at about 14 years of age, was repeated again and again, and the only possible conclusion was drawn from it, that the schools do not offer work which appeals to the boys. The educators showed the keenest desire to remedy this state of affairs, their favorite plan being an extension and broadening of the existing manual training work, between which and trade teaching they showed constant confusion. Against this was placed the dominant idea of the manufacturers that the school shops must be commercial shops, this idea being especially emphasized by Professor Higgins. It may be fairly said that the idea of these educators when reduced to its elements, was that the case would be met by an expansion of manual training and its incorporation into the entire school course from the beginning to the end.

During the session of Saturday morning S. B. Donnelly, member of the board of education of New York City, outlined the experience of the evening schools of that city, one of the chief features of which is the difficulty of holding the attention of the boys, while the attention of working mechanics is easily kept. The boy has an aversion to going to school and wants a short cut to a trade. He referred to the fact of the average boys leaving school at about 14 years of age and said that manual training was originally introduced into school work as an attraction which would hold them longer, but that it had not been a large success.

Charles H. Morse, secretary of the Massachusetts commission on industrial education, outlined the work already accomplished by that commission. The commission early recognized the necessity of providing for school work by men of mature years, in whom a new ambition had been aroused, and as an outgrowth of their efforts, more than twenty schools have already been established, with an attendance of more than 1000 adults.

He referred to the apprentice school system as now installed at the Lynn works of the General Electric Company, and pointed out that while eminently feasible in large, it was not feasible in small works because of the excessive cost compared with the small number of apprentices employed. He did not believe in the incorporation of industrial education in the work of the public schools, saying that that system was originally entered upon in several of the countries of Western Europe, including France and Germany, and that as the result of experience it had been given up, and the industrial schools removed entirely from the custody of the educational departments of those countries.

The annual business meeting was held after the sessions for the reading of papers, the election of officers and other routine and new business being disposed of. Carroll D. Wright was elected president and M. W. Alexander, vice-president. The most important piece of new business was the passing of a resolution authorizing the board of managers to appoint a salaried commissioner.

Testing Steel for Hardness

By E. R. Markham

The apparatus for testing steel for hardness, described in a recent issue of the American Machinist, calls to mind a device constructed and used several years ago for the purpose of determining the effect of various temperatures to which hardened steel was subjected when *drawing the temper*. The results obtained were incorporated in a paper that was presented to the American Society of Mechanical Engineers, December, 1902.

Our reason for making this testing apparatus was that we found it necessary to draw to various degrees of hardness the temper of the various cones used on the bicycle we were making, in order that each cone might best serve the purpose for which it was to be used.

Every man familiar with the heat treatment of steel knows that the first straw color, a faint yellow, is the first color visible when drawing the temper, and it shows that the steel has been heated to a temperature of about 430 degrees Fahrenheit. Many times a piece of hardened steel which is too brittle when "dead hard" is too soft for the purpose for which it is to be used, if it is drawn to this color. In order to get it into a condition where it will be sufficiently hard, and yet not too brittle, it is necessary to adopt some method of determining the proper amount of heat other than the oxide color on the surface, as this color does not show itself until the steel has been heated to 430 degrees, as stated.

Generally this is accomplished by heating in a kettle of oil and gaging the amount of heat by means of a thermometer which is placed in the oil. For certain purposes hardened steel placed in water and the water heated until it boils (212 degrees Fahrenheit), has the brittleness reduced sufficiently. This method is specially adapted to the removing of hardening strains. A mistake is sometimes made by placing hardened pieces directly into boiling water. The sudden expansion of the cold, brittle steel causes the more exposed or smaller portions to crack away from the heavy portions; but if the pieces are placed in water and the water and steel heated together, the expansion will be uniform and gradual and no bad results will follow.

We found that while certain cones had to be heated to about 500 degrees (brown) in order that they might be driven onto an axle and not break, certain other cones were too soft if drawn to a faint straw (430 degrees). We therefore drew the temper of various kinds of cones to various temperatures and tried them for hardness and also for brittleness.

In experimenting we found it necessary to design and construct an apparatus for use in testing the hardness, which we did by setting a diamond in the end of a vertical arm so designed that pressure could be applied by means of weights. With this we could test the relative hardness of pieces of hardened steel that had been softened somewhat by drawing the temper.

While we could mark "dead hard" pieces of steel as they came from the bath, the marks were faint, as we used a high-grade steel and employed a special system of heating and quenching that insured maximum hardness and toughness.

These experiments convinced us that there was not much difference in the hardness of a piece of steel as it came from the bath and one drawn to a temperature of 185 degrees. Beyond this, and up to 250 degrees there was apparently little difference in hardness but a marked difference in toughness, as was shown when broken in the testing machine.

The results convinced us that the reduction of hardness and brittleness was not proportional.

I realized when reading Mr. Shore's description of the "scleroscope," on page 747, Vol. 30, Part 2, of the American Machinist, that he has just the machine we should have had when making our teeth; but not having it, and not being able to get such an apparatus, we rigged up the contrivance mentioned. It served the purpose, as with it we could easily keep "tabs" on the annealing, the hardening and the tempering of our product.

If the carbon content of the steel was changed, it affected the hardness of the piece. Of course the testing apparatus did not show what had caused the change;

but as soon as a change was noticed, we could easily trace the cause. Therefore, such inventions as the "scleroscope," together with skill and carefulness in the treating of metals, enables us to make progress toward perfection.

Pressed-steel Automobile Frames

By E. J. Bartlett

Most people at all familiar with automobile construction doubtless know that cold-rolled sheet steel pressed into channel sections is the material generally employed for automobile frames. The grades of material, the construction of the frame and its manufacturing importance, in relation to the rest of the finished machine, may not, however, be so well known. The adoption of this type of frame has been gradual and only after extensive experiments in the earlier days of the automobile industry.

The automobile, following closely in the wake of the bicycle, quite naturally started off with more or less modified bicycle construction, which may explain in part the early tubular frames which were used and which were found entirely inadequate for such severe service.

Why Channeled Steel Was Used

Commercial irons, such as angles, tees and I-beams, were entirely too heavy in the standard sections. The natural form of special sections is perhaps the channel, since it can be easily pressed and formed in dies, and is light in proportion to its strength.

Its closest competitor is the wood frame reinforced by a steel plate, which is fairly satisfactory when the wood can be depended upon to be straight grained and sound throughout its length.

The grades of material used for the pressed-steel frame are commonly a good grade of steel of about 25-point carbon content, and the alloy steels of nickel and chrome nickel. The former is much the more generally used, as it is cheaper and answers all practical purposes. Specially light frames sometimes employ the alloy steels for the main side members, allowing such a thin section to be used that a very flexible frame results.

Pressed in Hydraulic Presses

The pressed-steel frame members are among those parts which nearly every automobile builder finds advisable to buy outside his own factory, as special heavy hydraulic machinery is necessary to use for pressing the steel to shape. A few manufacturers prefer to shape their frame members themselves by heating them and bending by hand to a steel templet, which is rather too expensive a process for the ordinary medium-priced car.

Forming the Side Member

In Fig. 1 is shown a side member—the most difficult part—in three stages of its formation. *A* shows the blank cut to the proper size to produce the required sections when pressed into the channel shape at *B*. At *C* is shown the finished member with tapering ends and the side

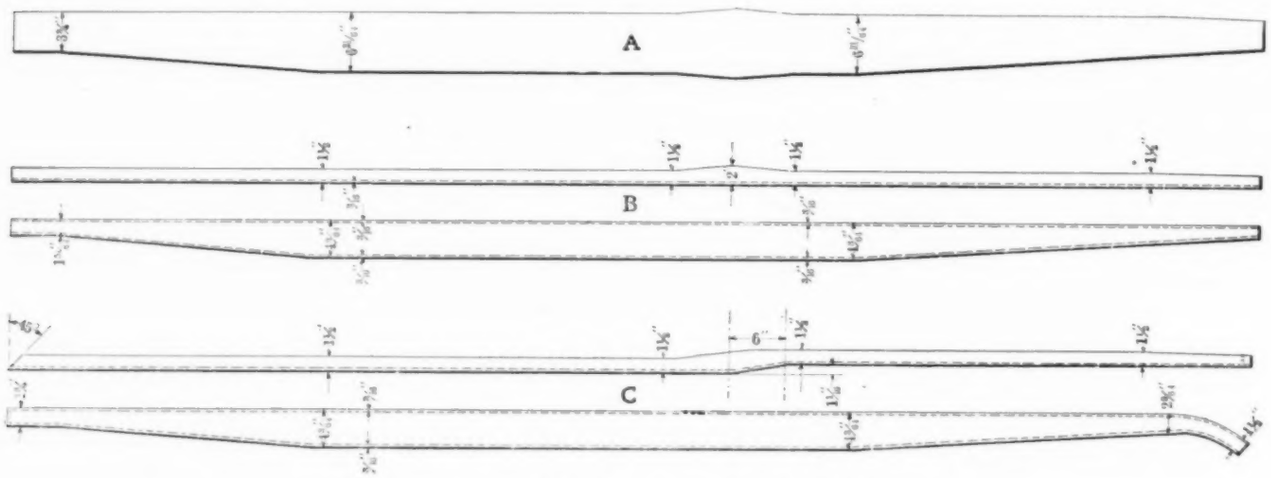


FIG. 1. SIDE MEMBER OF AN AUTOMOBILE FRAME

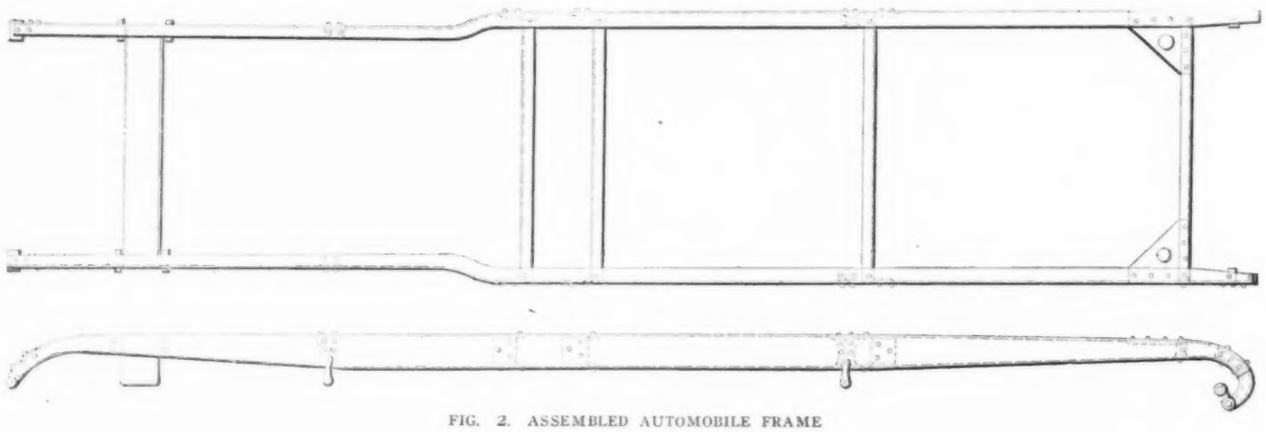


FIG. 2. ASSEMBLED AUTOMOBILE FRAME

offset, allowing the front of the frame to be narrower than the rear for clearance of the front wheels when turning.

After cutting the blanks, this member is shipped to the manufacturer; after inspection it goes to the machine shop, where all the holes necessary for the attachment of the various brackets are drilled by means of plate jigs or templets. The next operation is in the frame-assembling department, where all the brackets for the individual side members are riveted in place and the rear end trimmed and beveled to length. The same opera-

tions are carried out for the cross members which carry brackets.

SECOND OPERATION

For the second operation a set of side and cross members is placed on a large assembling fixture which is built up of numerous guides and supports; locating angles are securely bolted to a large base. All these locations are from the front of the frame, which is supported by pins, in the fixture, passing through the eye of the front-spring forward bracket.

This fixture insures the frame being square and true, correctly locates all cross members longitudinally, and preserves the proper drop in the cross members if there are slight variations in the parts which may require shimming or bending. The gussets are now added, their rivet holes transferred through by an air or electric drill, and these are riveted into place. The third operation consists of adding the additional parts, which from their construction require them to go on the assembled frame rather than the separate members.

An assembled frame, with all pressed-steel parts but with only the principal brackets, is shown in Fig. 2.

COST OF FRAMES

These operations are successive and are carried on in different parts of the frame-assembly department at the same time. The cost of construction of such a frame as shown, which is a fair average, is about $10. The cost of the pressed-steel members per set, when made in quantity, of carbon steel, is about $20, the alloy-steel frames being somewhat higher. The general dimensions of such frames are some 10 to 14 feet long, the side channels being from 3 to 5 inches deep, from 1½ to 2 inches wide, and made of from ⅛ to ¼ inch thick stock.

Lubricating Watches and Clocks

The whaling industry for which New Bedford, Massachusetts, once was famous has all but disappeared but it has left a rather novel industry in its wake, probably the only one in the world. Long before watches were made in this country the skippers of the whalers carried the best of English watches and it was very important that they should come as near splitting seconds as possible as their observations and nautical reckonings depended on their timepieces. It was the custom, and a very necessary one, to call at every port possible, and have their watches and chronometers compared, oiled and regulated and it was also the practice of watch tinkers as they were then called (and as too many of them really are today), to put a slip of paper in the case giving their name, address and the date on which it was regulated and oiled.

The leading watch tinker of New Bedford, where most of the whalers fitted out, was Ezra Kelley, whose little shop was on Union street along in the early part of the last century, probably about 1815. So it was perfectly natural that many skippers' chronometers bore Ezra Kelley's name and address and that it was seen by other watch tinkers in various parts of the world. It soon became evident to these various watch tinkers that Ezra Kelly had a specially good oil which he used, because the watches were in good condition and had no gum from the oil as was the case when the regular sperm oil was used.

So in the course of time inquiries began to come both by skippers and by mail asking what kind of oil he used and wanting some of it for their own use. Ezra usually forgot to tell them what the oil was but began to put it up in little bottles for watchmakers and sending these all over the world although of course in a small way at first.

It wasn't many years before the oil business amounted to considerably more than the watch tinkering and this was abandoned in favor of the refining of oil for watches. This oil comes from the jaw of the porpoise or the blackfish, both of which have the same quality of oil in this part of their anatomy and this oil has the property of neither gumming nor staining the delicate bearings of the fine watches.

In his early days Kelley had been a sailor and on one expedition was with a mate named Nye on a trip to Maracaibo, running the blockade to carry supplies to Bolivar when he was fighting for the independence of Colombia and in 1865 William F. Nye, son of the mate to Kelley, became interested in the business of refining porpoise oil. Ezra Kelley lived to be 96 years old and to see the little business grow into quite an industry, saw it move to Fish island in the Acushnet river, between New Bedford and Fair Haven, in 1884, where it is still located.

William F. Nye is still hale and hearty and on account of the difficulty of getting enough porpoises by depending on whalers to bring them in he has organized a fishing department of his own which follows the migrations of the porpoise and makes a business of catching enough for a continuous supply. This is, in brief, the story of the porpoise-oil industry whose products are now known all over the world.

Business Items

The offices of the Stoever Foundry and Manufacturing Company have been moved from Myerstown to Lebanon, Penn.

The Northern Electrical Manufacturing Company, Madison, Wis., has removed its St. Paul office from 21 East Fifth street to 516 Endicott building. T. E. Drohan, formerly superintendent of the Northern shops, is in charge.

On January 21 the American Tool Works Company, Cincinnati, Ohio, held its annual stockholders' meeting and the following officers were elected: Franklin Alter, president; J. B. Doan, vice-president and general manager; Robert S. Alter, secretary and Henry Luers, treasurer.

Trade Catalogs

J. H. Williams & Co., Brooklyn, N. Y. Circular illustrating and describing Vulcan chain pipe vise.

Rock Island Tool Company, Rock Island, Ill. Catalog of vises. Illustrated, 38 pages, 6x9 inches, paper.

H. H. Franklin Manufacturing Company, Syracuse, N. Y. 1908 catalog of automobiles. Illustrated, 36 pages, 8x10½ inches, paper.

Rockwell Engineering Company, 26 Cortlandt street, New York. Bulletin No. 13, illustrating and describing portable heaters for oil fuel.

Joseph Dixon Crucible Company, Jersey City, N. J. Booklet entitled "Dixon's Graphite Brushes." Illustrated, 12 pages, 3½x6 inches, paper.

Grönkvist Drill Chuck Company, 18 Morris street, Jersey City, N. J. Booklet describing Grönkvist drill chuck. Illustrated, 8 pages, 3½x6 inches, paper.

Miner & Peck Manufacturing Company, New Haven, Conn. Pamphlet containing directions for ordering parts of Peck's patent automatic drop lifter. Illustrated, 12 pages, 3½x6 inches, paper.

Want Advertisements

Rate 25 cents a line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for the ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendation or other papers of value should not be inclosed to unknown correspondents. Only bona fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

Miscellaneous Wants

Caliper list free. E. G. Smith Co., Columbia, Pa.

If you use small gears in large quantities, write Berry and Parker, Erie, Pa.

We buy or pay royalty for good patented machine or tool. Box 282, AMER. MACHINIST.

Hand power bending tools, labor-saving, money-making. Estep & Dolan, Sandwich, Ill.

Light, fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

Special machinery designed and built; duplicate parts, tools, jigs and dies. The Wade Machine Co., 133 Oliver St., Boston.

Special machinery accurately built. Screw machine and turret lathe work solicited. Robert J. Emory & Co., Newark, N. J.

Special machines designed and built; duplicate parts, model or experimental work. Mantle, Park ave. and 129th St., New York.

Automatic machinery designed; special purpose machines; working drawings. C. W. Pitman, 3519 Frankford Ave., Philadelphia, Pa.

Inventions, novelties, ideas, etc., developed; special machines designed. Albert Pott, M. E., 23 Platt St., New York, and Waterbury, Conn.

Do not trouble setting the tail stock over

on your lathe, get a Cincinnati center for tapers. Max C. Zange, 2827 Sidney Ave., Cincinnati, O.

Air, ammonia compressors, steam, gas engines, turbines, centrifugal pumps, special machinery designed; inventions developed. Box 814, AMERICAN MACHINIST.

Having successfully developed invention, in commercial condition, inventor desires capital or party to market same on a royalty basis; strict investigation requested. Box 839, AM. M.

Have you any copies of December 12 of the AMERICAN MACHINIST? We will give fifteen cents for every copy that we can get. AMERICAN MACHINIST, 505 Pearl St., New York.

Lathe and machine work of every description, patterns, gear cutting, screw machine work, iron, brass and aluminum castings. The Sipp Electric and Machine Co., Paterson, N. J.

Firms looking for an opportunity to sell goods on the German market should communicate with G. H. Davin, Bauerngasse 15, Nürnberg, who makes a specialty of introducing American specialties.

A large English firm of machine-tool importers having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMER. MACHINIST.

Machinery built to order and by contract; special parts made; gear cutting, automobile and pattern work, punch press and screw machine work, tools, dies, etc. Blair Tool and Machine Works, West and Morris Sts., New York City.

Special machinery and duplicate machine parts built to order; tools, jigs and experimental work; complete modern equipment. MacCordy Mfg. Co., Amsterdam, N. Y.

Rare Opportunity—Wanted—A party with $5,000 or more in cash to take an interest in and manage a company located in Canada; one who has had experience in the manufacturing of machinists' tools preferred; company has the best of connections with an established manufacturing concern in the United States; the financial and selling end of business will require his particular attention. Box 833, AMERICAN MACHINIST.

Situations Wanted

Classification indicates present address of advertiser, nothing else.

CONNECTICUT

By trying another superintendent more up to date, you will find your product will not be as slow and costly; expert mechanic, executive, good organizer and systematizer, long and varied experience; a hustler; age 38; light or medium manufacturing. Box 836, AMERICAN MACHINIST.

ILLINOIS

Assistant superintendent manufacturing plant 3 years; 5 years' previous experience in machine shop and drafting room; 32 years old; Yale graduate; member of A. S. M. E.; location, in or near Chicago. Box 732, AMERICAN MACHINIST.

First-class mechanic; 18 years' experience as toolmaker, tool room foreman and superintendent on typewriter and sewing machine work; desires position as superintendent or assistant; best of references furnished. Box 805, AMERICAN MACHINIST.

MASSACHUSETTS

Draftsman and designer; 15 years' experience on machinery in general, automatic and interchangeable; engines and steam turbines specialty; developing new ideas. Box 843, AMERICAN MACHINIST.

NEBRASKA

Position as salesman; well up in foundry supplies, machine tools, tool steels, steam and gasolene engines; practical machinist, toolmaker, draftsman, designing engineer and salesman; 17 years in business, 10 as general superintendent and salesman; 32 years old; married; sober, and used to big things; personal interview if possible. Box 830, AMERICAN MACHINIST.

NEW JERSEY

Draftsman wishes change; technical graduate, three years in machine shop, total engineering experience, eight years; moderate salary. Box 801, AMERICAN MACHINIST.

NEW YORK

Mechanical draftsman wishes position. Box 828, AMERICAN MACHINIST.

Mechanical draftsman wishes position. Address Box 840, AMERICAN MACHINIST.

Draftsman; (25); 5 years' shop and 4 drafting general experience. Address "P. A. B.," 261 W. 20th St., New York.

Draftsman and designer of pumps and pumping engines wants position; references. Box 835, AMERICAN MACHINIST.

Position by mechanical engineer and draftsman; experienced in plant work and furnace design. Box 832, AMERICAN MACHINIST.

Mechanical engineer; college graduate; one year shop, four years' drafting experience, wants position. Box 846, AMER. MACHINIST.

Wanted—A position as chief engineer, mechanical and electrical; can furnish the best of references by inquiries. Box 183, AM. M.

Superintendent or assistant; a producer, familiar with modern organization, shop systems and tool design, desires position. Box 844, AMERICAN MACHINIST.

Mechanical draftsman with modern shop practice; have had charge; desires position as chief draftsman or superintendent of manufacturing plant. Box 838, AM. MACH.

Situation wanted by a mechanical draftsman; 16 years' experience in Corliss steam air compressors, gas and gasolene engines; A-1 references. Box 816, AMER. MACHINIST.

As superintendent or assistant by a resourceful mechanic and executive; age 35; experienced on high grade interchangeable work, tools, jigs, dies, brass, iron, etc. Box 841, AMERICAN MACHINIST.

Factory accountant—Practical man on machine shop and foundry costs; also first-class bookkeeper and systematizer; desires position with manufacturing concern; modern methods and satisfactory results guaranteed. Box 821, AMERICAN MACHINIST.

Foreman toolmaker or master mechanic desires change; location Greater New York or vicinity; expert on tools, jigs, fixtures and special machine design; well up in modern shop; practical and successful handler of men; reasonable salary. Address Box 842, AMERICAN MACHINIST.

PENNSYLVANIA

Toolmaker, machinist, wants position. Box 837, AMEICAN MACHINIST.

Machine shop foreman, experienced toolmaker, desires change; shop or department; Philadelphia or vicinity. Box 825, AM. M.

Responsible position with manufacturer of pulleys, hangers, couplings, etc.; thoroughly familiar with details and with special machinery for their rapid production; practical, technical. Box 845, AMERICAN MACHINIST.

RHODE ISLAND

Chief draftsman wants position as a developer of new machinery, or to redesign line of machinery; 10 years' experience as draftsman; 6 years' as machinist. Box 826, AMERICAN MACHINIST.

FOREIGN

Russia—Russian mechanical engineer open for position in Russia; machinery designing and shop work experience; two years' practice with American machine concerns; prefer a large concern with modern methods; 35 years old. S. S. Gulanitzky, Kieff, Tarasovskaja, 29.

Help Wanted

Classification indicates present address of advertiser, nothing else.

CANADA

Carbonizer; must be thoroughly experienced; give full particulars and state salary expected. Box 834, AMERICAN MACHINIST.

ILLINOIS

Wanted—A first-class mechanical draftsman; must be able to make accurate and reliable layouts on typewriter work. Apply by letter only, giving full outline of experience, age, references and salary expected to start. M. B. Sargent, 127 Rees St., Chicago.

NEW JERSEY

Wanted—First-class mechanical superintendent for a printing machine plant near New York; must have executive ability, up-to-date methods and be capable of producing best results at lowest cost; state age, experience and salary expected. "Permanent," AMERICAN MACHINIST.

Wanted—First-class, experienced salesmen to sell printing machinery in New York City and New York State; also one to travel in other States; only men of ability and mechanical experience need apply; applicants must state full particulars, age and salary desired. Confidential, AMERICAN MACHINIST.

Wanted—Boiler room foreman capable of running economically 4000 horse-power Climax boilers; preference given to one able and willing to take salary out of saving shown over present cost of operation; permanent position to right man; give age, education and experience. "New Jersey," Box 831, AMERICAN MACHINIST.

NEW YORK

Wanted—A-1 mechanical draftsman, with shop experience preferred; state age, experience and salary expected. Box 827, AM. M.

Wanted—Mechanical draftsman familiar with mixing and kneading machinery for bread doughs, chemicals, paint, etc.; to a man thoroughly conversant with this line of machinery, we can offer a good position; state age, experience, if married or single, and salary expected. Address "Mixers," AM. MACH.

Superintendent with experience and good executive ability, capable of taking full charge of the manufacturing end of a modern plant employing 250 men in the manufacture of a line of A-1 machine tools; location a pleasant town of 10,000 inhabitants, moderate rents, etc.; this is a good opportunity for the right man; state age, experience and salary expected, with references. Address "Manufacturer," AMERICAN MACHINIST.

PENNSYLVANIA

Wanted—First-class pattern maker for small shop; young man with experience on pumps or engines preferred; give full details, experience, references and wages expected. Box 829, AMERICAN MACHINIST.

FOREIGN

Betriebs-Assistent gesucht von grosser Berliner Maschinenfabrik. Bewerber sollen ähnliche Stellung im Präzisions-Dampfmaschinenbau bezw. Werkzeugmaschinenbau erfolgreich bekleidet haben. Werkstattpraxis Bedingung, Konstruktionspraxis erwünscht. Offerten mit Bildungsgang, Zeugnisabschriften, Gehaktsansprüchen und Eintrittstermin unter J. U. 5912 befördert Annoncen-Expedition Rudolf Mosse, Berlin, S. W. Deutschland.

For Sale

For Sale—Foundry, wood and iron machine shop; all equipped. Box 74, Albion, N. Y.

For Sale—Well equipped general machine shop in New Jersey; employing 15 to 20 hands; good reason for selling. P. O. Box 1216, New York City.

For Sale—Ten volume library, covering completely the work of the engineer and machinist; good as new; cost $50; will sell for $15. Address "T. M. T.," Box 425, Chicago.

For Sale—Cyclopedia for modern shop practice, four volumes; bound in green morocco leather. Practically new; cost $18; will sell for $6. Address "L. N. O.," Box 425, Chicago, Ill.

Patent for sale; an inexpensive bevel and mitre gear cutting attachment for use with a shaper; will unquestionably do a class of work which has heretofore been possible only with very high priced special machines. Address W. W. Clippinger, 80 Atlas Bank Bldg., Cincinnati, Ohio.

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Boosters

Burke Electric Co., Erie, Pa.
C & C Electric Co., New York.
Crocker - Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Northern Elec. Mfg. Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sprague Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Boring and Drilling Machines, Horizontal

Barnes Co., W. F. & John, Rockford, Ill.
Smith Co., Prov., R. I.
Betts Mach. Co., Wilmington, Del.
Binsse Mach. Co., Newark, N. J.
Boynton & Plummer, Worcester, Mass.
Detrick & Harvey Mach. Co., Wilmington, Del.
Fitchburg Machine Works, Fitchburg, Mass.
Fosdick Mach. Tool Co., Cin., O.
Gisholt Mach. Co., Madison, Wis.
Lucas Mach. Tool Co., Cleveland, Ohio.
McCabe, J. J., New York.
Motch & Merryweather Machinery Co., Cleveland, O.
Newton Machine Tool Wks., Inc., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Rockford Drilling Mach. Co., Rockford, Ill.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Stow Mfg. Co., Binghamton, N. Y.
Vandyck Churchill Co., New York.
Whitcomb - Blaisdell Mach. Tool Co., Worcester, Mass.

Boring and Turning Mills, Vertical

American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Baush Mach. Tool Co., Springfield, Mass
Betts Mach. Co., Wilmington, Del.
Bullard Mach. Tool Co., Bridgeport, Conn.
Colburn Mach. Tool Co., Franklin, Pa.
Gisholt Mach. Co., Madison, Wis.
Harrington, Son & Co., Edwin, Philadelphia, Pa.

Boring and Turning Mills, Vertical —*Continued.*

McCabe, J. J., New York.
Niles-Bement-Pond Co, New York.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.

Boring Tools

Armstrong Bros. Tool Co., Chicago, Ill.

Boxes, Tote

Cleveland Wire Spring Co., Cleveland, O.
Lyon Metallic Mfg. Co., Aurora, Ill.

Box Tools, Roughing

Bardons & Oliver, Cleveland, O.

Brackets, Lamp

Standard Welding Co., Cleveland, Ohio.

Brazing

Industrial Oxygen Co., New York.

Broaching Machines

Harrington, Son & Co., Edwin, Philadelphia, Pa.
Lapointe Mach. Tool Co., Hudson, Mass.

Bulldozers

National Machinery Co., Tiffin, O.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Toledo Machine and Tool Co., Toledo, Ohio.

Cabinets, Tool

Armstrong Bros. Tool Co., Chicago, Ill.
Hammacher, Schlemmer & Co., New York.
Lyon Metallic Mfg. Co., Aurora, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.

Calipers

Athol Mach. Co., Athol, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Sawyer Tool Mfg. Co., Fitchburg, Mass.
Slocomb Co., J. T., Providence, R. I.
Starrett Co., L. S., Athol, Mass.

Cams

Bilgram, Hugo, Phila., Pa.
Boston Gear Works, Norfolk Downs, Mass.

Carborundum

See Grinding Wheels.

Carborundum Paper and Cloth

Carborundum Co., Niagara Falls, N. Y.

Case-Hardening

Rogers & Hubbard Co., Middletown, Conn.
Williams & Co., J. H., Brooklyn, N. Y.

Cast Iron Brazing

Industrial Oxygen Co., New York.

Castings, Brass and Bronze

Lumen Bearing Co., Buffalo, N. Y.
Neptune Meter Co., Long Island City, N. Y.
Rowell Co., W. G., Bridgeport, Ct.

Castings, Die Molded

Franklin Mfg. Co., H. H., Syracuse, N. Y.

Castings, Iron

Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Cell Drier Machine Co., Taunton, Mass.
Farrel Fdry. & Mach. Co., Ansonia, Conn.

Machine Department

Chain Department

Miscellaneous Department

We are now well settled in our New Factory and

Ready to Show Results

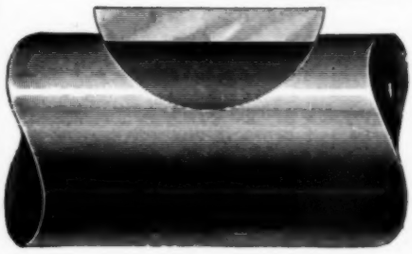
Prompt Delivery and Constant Improvement in Quality

In our effort to possess the Finest Chain Plant in existence and to maintain the highest degree of Accuracy, Efficiency and Finish we are going to the very limit.

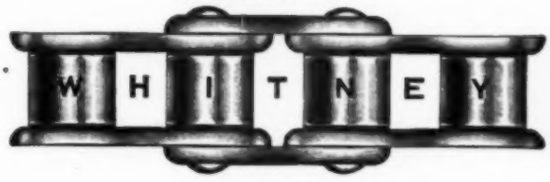
We will now make all sizes of Roller and Bushing Chains for which there is a reasonable demand.

"WHITNEY" MACHINE KEYS and KEY-SEAT CUTTERS
(For the Woodruff Patent System of Keying)

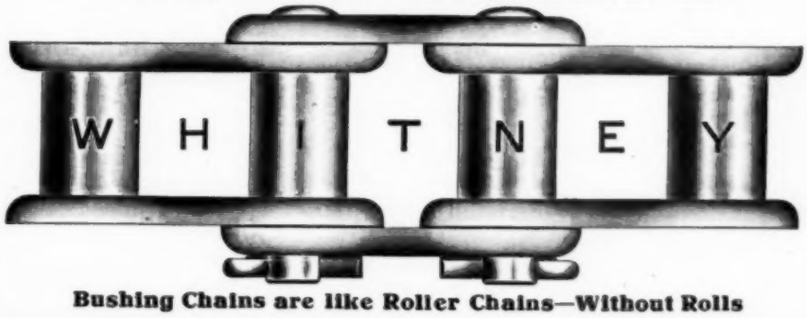
We carry 95 regular Sizes of keys and cutters in stock for immediate delivery.



Roller Chain



"Whitney" Detachable Bushing Chain—Patented



Bushing Chains are like Roller Chains—Without Rolls

The Whitney Mfg. Co.

Hartford, Conn.

Castings, Steel

Bethlehem Steel Co., So. Bethlehem, Pa.
Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Cammel, Laird & Co., New York.
Carpenter Steel Co., Reading, Pa.
Curtis & Co. Mfg. Co., St. Louis, Mo.
Farrel Fdry & Mach. Co., Ansonia, Conn.
Krupp (Thos. Prosser & Son), New York.

Cement, Cast Steel

Clark Cast Steel Cement Co., Shelton, Conn.

Centering Machines

Hendey Mach. Co., Torrington, Conn.
National Machine Co., Hartford, Conn.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Whiton Mach. Co., D. E., New London, Conn.

Centers, Planer

Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Woodward & Powell Planer Co., Worcester, Mass.

Chains, Driving

Baldwin Chain & Mfg. Co., Worcester, Mass.
Boston Gear Works, Norfolk Downs, Mass.
Cullman Wheel Co., Chicago, Ill.
Diamond Chain & Mfg. Co., Indianapolis, Ind.
Link-Belt Co., Philadelphia, Pa.
Morse Chain Co., Ithaca, N. Y.
Whitney Mfg. Co., Hartford, Ct.

Chisels, Cold

Whitman & Barnes Mfg. Co., Chicago, Ill.

Chucking Machines

American Tool Wks. Co., Cin., O.
Bardons & Oliver, Cleveland, O.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Automatic Machine Co., Cleveland, O.
Gisholt Mach. Co., Madison, Wis.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
Reed Co., F. E., Worcester, Mass.
Warner & Swasey Co., Cleveland, Ohio.
Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.

Chucks, Drill

Almond Mfg. Co., T. R., Brooklyn, N. Y.
Brown & Co., R. H., New Haven, Conn.
Cleveland Twist Drill Co., Cleveland, O.
Cushman Chuck Co., Hartford, Conn.
Grönkvist Drill Chuck Co., Jersey City, N. J.
Horton & Son Co., E., Windsor Locks, Conn.
Jacobs Mfg. Co., Hartford, Conn.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt Chuck Co., Frankfort, N. Y.
Skinner Chuck Co., New Britain, Conn.
Standard Tool Co., Cleveland, O.
Trump Bros. Mach. Co., Wilmington, Del.
Whitney Mfg. Co., Hartford, Ct.
Whiton Mach. Co., D. E., New London, Conn.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Chucks, Lathe

Cushman Chuck Co., Hartford, Conn.
Gisholt Mach. Co., Madison, Wis.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Horton & Son Co., E., Windsor Locks, Conn.
Niles-Bement-Pond Co., New York.
Pratt Chuck Co., Frankfort, N. Y.
Skinner Chuck Co., New Britain, Conn.
Union Mfg. Co., New Britain, Ct.
Whiton Mach. Co., D. E., New London, Conn.

Chucks, Planer

Niles-Bement-Pond Co., New York.
Skinner Chuck Co., New Britain, Conn.

Chucks, Split

Hardinge Bros., Chicago, Ill.
Rivett Lathe Mfg. Co., Boston, Mass.

Circuit Breakers

Crocker - Wheeler Co., Ampere, N. J.
Electric Controller & Supply Co., Cleveland, Ohio.
General Electric Co., New York.
Western Electric Co., Chicago, Ill.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Clamps

Billings & Spencer Co., Hartford, Conn.
Hammacher, Schlemmer & Co., New York.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Le Count, Wm. G., So. Norwalk, Conn.
Starrett Co., L. S., Athol, Mass.
Tudor Mfg. Co., Taunton, Mass.
Williams & Co., J. H., Brooklyn, N. Y.

Clutches, Friction

Caldwell, Son & Co., H. W., Chicago, Ill.
Cowanesque Valley Iron Wks., Cowanesque, Pa.
Eastern Machinery Co., New Haven, Conn.
Evans Friction Cone Co., Newton Centre, Mass.
Johnson Mach. Co., Carlyle, Hartford, Conn.
Link-Belt Co., Philadelphia, Pa.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.

Clutches, Magnetic

Electric Controller & Supply Co., Cleveland, O.

Coal Handling Machinery

Link-Belt Co., Philadelphia, Pa.

Coils

Standard Welding Co., Cleveland, Ohio.

Collets and Attachments, Spring

Adjustable Collet Co., Cleveland, Ohio.

Compound, Core

Obermayer Co., S., Cincinnati, O.

Compound, Pipe Joint

Dixon Crucible Co., Joseph, Jersey City, N. J.

Compressors, Air

Blaisdell Machinery Co., Bradford, Pa.
Blanchard Mach. Co., Cambridge, Mass.
Bury Compressor Co., Erie, Pa.
Chicago Pneumatic Tool Co., Chicago, Ill.
Clayton Air Compressor Works, New York.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Pneumatic Tool Co., Montour Falls, N. Y.
Ingersoll-Rand Co., New York.
Sampson & Co., Geo. H., Boston, Mass.
Spacke Machine Co., F. W., Indianapolis, Ind.

Compressors, Gas

Blaisdell Machinery Co., Bradford, Pa.

Cones, Friction

Evans Friction Cone Co., Newton Centre, Mass.

Connecting Rods and Straps

Bethlehem Steel Co., So. Bethlehem, Pa.
Standard Connecting Rod Co., Beaver Falls, Pa.
Tindel-Morris Co., Eddystone, Pa.

Contract Work

Blanchard Mach. Co., Cambridge, Mass.
Cell Drier Machine Co., Taunton, Mass.
Dietz Machine Works, Phila., Pa.
Ingle Machine Co., Rochester, N. Y.
Manville Bros. Co., Waterbury, Conn.
Merritt, Jos., Hartford, Conn.
Turner Mach. Co., Danbury, Ct.

Controllers and Starters, Electric Motor

Case Mfg. Co., Columbus, O.
Crocker - Wheeler Co., Ampere, N. J.
Electric Controller & Supply Co., Cleveland, O.
General Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Conveyors, Automatic

Link-Belt Co., Philadelphia, Pa.

Coping Machines

Long & Allstatter Co., Hamilton, Ohio.
Niles-Bement-Pond Co., New York.

Corundum

See Grinding Wheels.

Cotters

Adjustable Collet Co., Cleveland, Ohio.
Cleveland Twist Drill Co., Cleveland, Ohio.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Standard Tool Co., Cleveland, O.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Counterbores

Cleveland Twist Drill Co., Cleveland, Ohio.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Slocomb Co., J. T., Prov., R. I.
Starrett Co., L. S., Athol, Mass.

Counters, Machinery

Veeder Mfg. Co., Hartford, Ct.

Countershafts

Almond Mfg. Co., T. R., Brooklyn, N. Y.
Builders Iron Foundry, Providence, R. I.
Coates Clipper Mfg. Co., Worcester, Mass.
Evans Friction Cone Co., Newton Centre, Mass.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
Mossberg Wrench Co., Central Falls, R. I.
Norton Grinding Co., Worcester, Mass.
Smith Countershaft Co., Boston, Mass.

Countershafts, Friction

Evans Friction Cone Co., Newton Centre, Mass.
Wilmarth & Morman Co., Grand Rapids, Mich.

Countershafts, Speed Changing

Evans Friction Cone Co., Newton Centre, Mass.
Gisholt Mach. Co., Madison, Wis.

Counting and Printing Wheels

Franklin Mfg. Co., H. H., Syracuse, N. Y.

Couplers, Hose

Ingersoll-Rand Co., New York.

Couplings, Shaft

Almond Mfg. Co., T. R., Brooklyn, N. Y.
Caldwell & Son Co., H. W., Chicago, Ill.
Davis Machine Co., W. P., Rochester, N. Y.
Link-Belt Co., Philadelphia, Pa.
Nicholson & Co., W. H., Wilkes-Barre, Pa.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Gauge Steel Co., Beaver Falls, Pa.

Crane Pullers

Walker, N. U., Boston, Mass.

Cranes

Brown Hoisting Mach. Co., Cleveland, O.
Byram & Co., Inc., Detroit, Mich.
Case Mfg. Co., Columbus, O.
Chicago Pneumatic Tool Co., Chicago, Ill.
Cleveland Crane & Car Co., Wickliffe, O.
Crescent Forgings Co., Oakmont, Pa.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Pneumatic Tool Co., Montour Falls, N. Y.
Manning, Maxwell & Moore, Inc., New York.
Maris Bros., Philadelphia, Pa.
Moore Co., Franklin, Winsted, Ct.
Nicholls, Wm. S., New York.
Niles-Bement-Pond Co., New York.
Northern Engineering Works, Detroit, Mich.
Obermayer Co., S., Cincinnati, O.
Pawling & Harnischfeger, Milwaukee, Wis.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.
Yale & Towne Mfg. Co. New York.

Crank Pin Turning Machines

Niles-Bement-Pond Co., New York.
Underwood & Co., H. B., Philadelphia, Pa.

Crank Shafts

Bethlehem Steel Co., So. Bethlehem, Pa.
Krupp (Thos. Prosser & Son), New York.
Standard Connecting Rod Co., Beaver Falls, Pa.
Tindel-Morris Co., Eddystone, Pa.

Crucibles

Dixon Crucible Co., Joseph, Jersey City, N. J.
Obermayer Co., S., Cincinnati, O.

Crushers

Farrel Fdry. & Mach. Co., Ansonia, Conn.
Niles-Bement-Pond Co., New York.
Link-Belt Co., Philadelphia, Pa.

Cupolas, and Ladles, Foundry

Byram & Co., Inc., Detroit, Mich.
Obermayer Co., S., Cincinnati, O.
Paxson Co., J. W., Phila., Pa.
Stevens, F. B., Detroit, Mich.

Cups and Covers, Oil

Bay State Stamping Works, Worcester, Mass.
Besly & Co., Chas. H., Chicago, Ill.
Elliott Chemical Works, Newton, Mass.
Lunkenheimer Co, Cincinnati, O.
Winkley Co., Detroit, Mich.

Cups, Grease

Lunkenheimer Co., Cincinnati, O.

Cutters, Milling

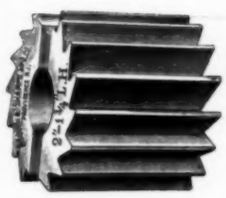
Adams Co., Dubuque, Iowa.
Becker-Brainard Milling Machine Co., Hyde Park, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Twist Drill Co., Cleveland, O.
Hardinge Bros., Chicago, Ill.
Harrison & Knight Mfg. Co., Newark, N. J.
Ingersoll Milling Mach. Co., Rockford, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Nash Company, Geo., New York.
Pratt & Whitney Co., Hartford, Conn.
Rogers Works, Jno. M., Gloucester City, N. J.
Standard Tool Co., Cleveland, O.
Union Twist Drill Co., Athol, Mass.
Ward & Son, Edgar T., Boston, Mass.
Whitney Mfg. Co., Hartford, Ct.

Cutting-off Machines

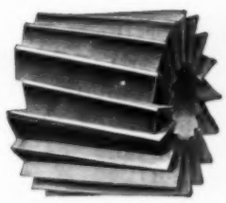
Armstrong Bros. Tool Co., Chicago, Ill.
Bignall & Keeler Mfg. Co., Edwardsville, Ill.
Brown & Sharpe Mfg. Co., Providence, R. I.
Davis Machine Co., W. P., Rochester, N. Y.
Hurlbut-Rogers Mach. Co., South Sudbury, Mass.

Brown & Sharpe Mfg. Co.

Providence, R. I., U. S. A.

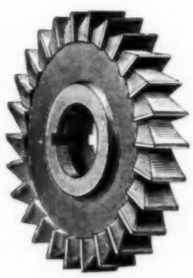


B. & S. or Quality Cutters



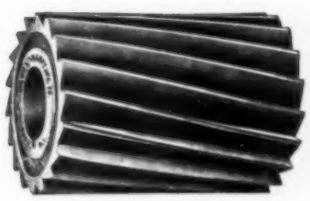
The fact of quality has been noted so many times as inherent in B. & S. Cutters that users unconsciously link the Cutter and its characterestic as one and the same.

The reason is as follows. For over forty-five years we have manufactured all varieties of cutters and during this time have been cutter users as well. Being cutter users, gives the advantage of thoroughly testing out B. & S. Cutters on the work for which they are intended and places upon the market only those cutters that have long proved their



Efficiency and Quality

Cutter Lists giving complete description of all B. & S. stock cutters sent free to any address.



Cutting-off Machines—*Cont.*
Newton Mach. Tool Wks., Philadelphia, Pa.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Schmitz, August, Dusseldorf, Germany.
Tindel-Morris Co., Eddystone, Pa.
Vandyck Churchill Co., New York.

Cutting-off Tools
Armstrong Bros. Tool Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Cleveland Twist Drill Co., Cleveland, O.
Fitchburg Machine Works, Fitchburg, Mass.
O. K. Tool Holder Co., Shelton, Conn.
Pratt & Whitney Co., Hartford, Conn.
Western Tool & Mfg. Co., Springfield, O.

Diamond Tools
American Emery Wheel Co., Providence, R. I.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Dickinson, Thos. L., New York.
Safety Emery Wheel Co., Springfield, O.

Dies, Sheet Metal
American Tube & Stamping Co., Bridgeport, Conn.
Bliss Co., E. W., Brooklyn, N. Y.
Consolidated Press and Tool Co., Hastings, Mich.
Ferracute Mach. Co., Bridgeton, N. J.
Globe Machine & Stamping Co., Cleveland, O.
Manville Bros. Co., Waterbury, Conn.
Risdon Tool Works, Waterbury, Conn.
Swaine Mfg. Co., Fred J., St. Louis, Mo.
Toledo Machine and Tool Co., Toledo, Ohio.

Dies, Sub-Press
Risdon Tool Works, Waterbury, Conn.
Sloan & Chace Mfg. Co., Newark, N. J.
Waltham Machine Works, Waltham, Mass.

Dies, Threading, Opening
Errington, F. A., New York.
Foote-Burt Co., Cleveland, O.
Geometric Tool Co., New Haven, Conn.
Jones & Lamson Machine Co., Springfield, Vt.
Pratt & Whitney Co., Hartford, Conn.

Dowel Pins
Winkley Co., Hartford, Conn.

Drawing Boards and Tables
Alteneder & Son, Theo., Philadelphia, Pa.
Keuffel & Esser Co., New York.
Kolesch & Co., New York.

Drawing Materials
Alteneder & Son, Theo., Philadelphia, Pa.
Handy Mfg. Co., Chicago, Ill.
Keuffel & Esser Co., New York.
Kolesch & Co., New York.
Technical Supply Co., Scranton, Pa.

Drafting Machines
Universal Drafting Mach. Co., Cleveland, O.

Drilling Machines, Bench
American Watch Tool Co., Waltham, Mass.
Barnes Co., W. F. & John, Rockford, Ill.
Boynton & Plummer, Worcester, Mass.
Ingersoll-Rand Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentice Bros. Co., Worcester, Mass.

Milling Machines, Bench—*Continued.*
Rockford Drilling Mach. Co., Rockford, Ill.
Slate Machine Co., Dwight, Hartford, Conn.
Sloan & Chace Mfg. Co., Newark, N. J.
U. S. Electrical Tool Co., Cincinnati, O.

Drilling Machines, Boiler
American Tool Works Co., Cin., O.
Bickford Drill & Tool Co., Cincinnati, O.
Boynton & Plummer, Worcester, Mass.
Foote-Burt Co., The, Cleveland, O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.

Drilling Machines, Electric
Chicago Pneumatic Tool Co., Chicago, Ill.
Clark, Jr., Elec. Co., Inc., Jas., Louisville, Ky.

Drilling Machines, Multiple Spindle
American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Barnes Co., W. F. & John, Rockford, Ill.
Baush Mach. Tool Co., Springfield, Mass.
Bickford Drill & Tool Co., Cincinnati, O.
Flather Planer Co., Mark, Nashua, N. H.
Foote-Burt Co., The, Cleveland, Ohio.
Fosdick Mach. Tool Co., Cin., O.
Hardinge Bros., Chicago, Ill.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Moline Tool Co., Moline, Ill.
National Machine Co., Hartford, Conn.
Newton Mach. Tool Works, Inc., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Rockford Drilling Mach. Co., Rockford, Ill.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Slate Machine Co., Dwight, Hartford, Conn.
Taylor & Fenn Co., Hartford, Ct.

Drilling Machines, Portable
Cincinnati Elec. Tool Co., Cin., O.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Coates Clipper Mfg. Co., Worcester, Mass.
Gem Mfg. Co., Pittsburg, Pa.
Hisey-Wolf Mach. Co., Cin., O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
Stow Mfg. Co., Binghamton, N. Y.
U. S. Electrical Tool Co., Cincinnati, O.

Drilling Machines, Radial
American Tool Wks. Co., Cin., O.
Baush Mach. Tool Co., Springfield, Mass.
Bickford Drill & Tool Co., Cincinnati, O.
Dreses Mach. Tool Co., Cin., O.
Fitchburg Machine Works, Fitchburg, Mass.
Foote-Burt Co., Cleveland, O.
Fosdick Mach. Tool Co., Cin., O.
Gang Co., Wm. E., Cincinnati, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Morris Foundry Co., Jno. B., Cincinnati, O.
Mueller Mach. Tool Co., Cin., O.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.
Wormer Mchy. Co., C. C., Detroit, Mich.

Drilling Machines, Turret
Niles-Bement-Pond Co., New York.

Drilling Machines, Upright
American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Barnes Co., W. F. & John, Rockford, Ill.
Beaman & Smith Co., Prov., R. I.
Boynton & Plummer, Worcester, Mass.
Cincinnati Mach. Tool Co., Cincinnati, O.
Clark, Jr., Elec. Co., Inc., Jas., Louisville, Ky.
Davis Machine Co., W. P., Rochester, N. Y.
Fosdick Mach. Tool Co., Cin., O.
Foote-Burt Co., Cleveland, O.
Gould & Eberhardt, Newark, N. J.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.
Hoefer Mfg. Co., Freeport, Ill.
Kern Machine Tool Co., Cincinnati, O.
Knight Machry. Co., W. B., St. Louis, Mo.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Mechanics Machine Co., Rockford, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
National Machine Co., Hartford, Conn.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Rockford Drilling Mach. Co., Rockford, Ill.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Sibley Machine Tool Co., South Bend, Ind.
Slate Machine Co., Dwight, Hartford, Conn.
Sloan & Chace Mfg. Co., Newark, N. J.
Taylor & Fenn Co., Hartford, Conn.
Vandyck Churchill Co., New York.
Whitney Mfg. Co., Hartford, Ct.
Wiley & Russell Mfg. Co., Greenfield, Mass.
Wormer Mchry. Co., C. C., Detroit, Mich.

Drills, Center
Cleveland Twist Drill Co., Cleveland, O.
Morse Twist Drill & Machine Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Slocomb Co., J. T., Prov., R. I.
Standard Tool Co., Cleveland, O.

Drills, Hand
Cincinnati Electrical Tool Co., Cincinnati, O.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Coates Clipper Mfg. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
U. S. Electrical Tool Co., Cincinnati, O.

Drills, Pneumatic
Chicago Pneumatic Tool Co., Chicago, Ill.
Clayton Air Compressor Works, New York.

Drills, Rail
Foote-Burt Co., Cleveland, O.
General Pneumatic Tool Co., Montour Falls, N. Y.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Standard Tool Co., Cleveland, O.

Drills, Ratchet
Armstrong Bros. Tool Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Cleveland Twist Drill Co., Cleveland, O.
Hisey-Wolf Mach. Co., Cin., O.

Drills, Ratchet—*Continued.*
Parker Co., Chas., Meriden, Conn.
Pratt & Whitney Co., Hartford, Conn.
Rogers Works, John M., Gloucester City, N. J.
Standard Tool Co., Cleveland, O.

Drills, Rock
Ingersoll-Rand Co., New York.
Northern Electrical Mfg. Co., Madison, Wis.

Drill Speeder
Graham Mfg. Co., Providence, R. I.

Drying Apparatus
Sturtevant Co., B. F., Hyde Park, Mass.

Dynamos
Burke Electric Co., Erie, Pa.
C & C Electric Co., New York.
Crocker - Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Jantz & Leist Elec. Co., Cin., O.
Northern Elec. Mfg. Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Roth Bros. & Co., Chicago, Ill.
Sturtevant Co., B. F., Hyde Park, Mass.
Triumph Electric Co., Cincin., O.
Western Electric Co., Chicago, Ill.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Electrical Supplies
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Crocker - Wheeler Co., Ampere, N. J.
Electric Controller & Supply Co., Cleveland, O.
General Electric Co., New York.
Jantz & Leist Elec. Co., Cin., O.
Northern Elec. Mfg. Co., Madison, Wis.
Roth Bros. & Co., Chicago, Ill.
Triumph Electric Co., Cincin., O.
Wagner Elec. Mfg. Co., St. Louis, Mo.
Western Electric Co., Chicago, Ill.
Weston Elec. Instrument Co., Newark, N. J.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Electrically Driven Tools and Machinery
American Tool Wks. Co., Cin., O.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Cincinnati Electrical Tool Co., Cincinnati, O.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Crescent Forgings Co., Oakmont, Pa.
Electric Controller & Supply Co., Cleveland, O.
Hisey-Wolf Mach. Co., Cincin., O.
Roth Bros. & Co., Chicago, Ill.
U. S. Electrical Tool Co., Cincinnati, O.
Western Electric Co., Chicago, Ill.

Elevators
Albro-Clem Elevator Co., Philadelphia, Pa.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Link-Belt Co., Philadelphia, Pa.

Emery Wheels
See Grinding Wheels.

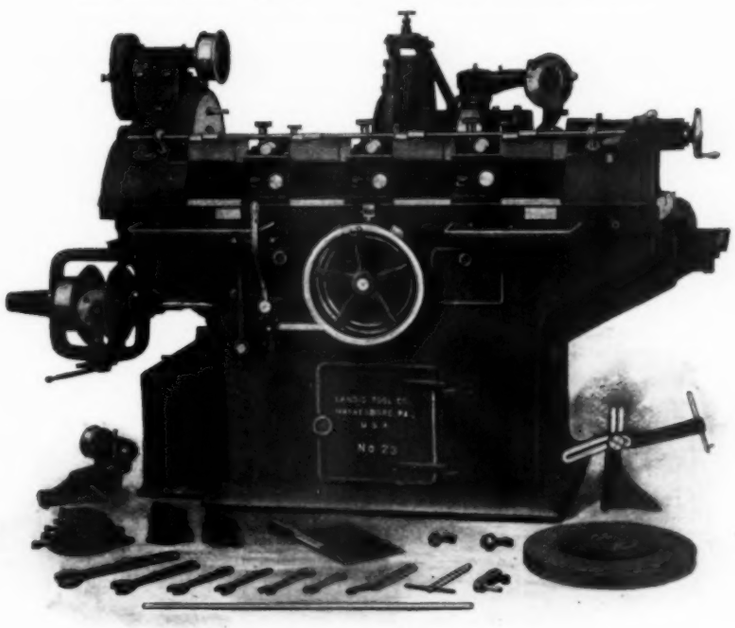
Emery Wheel Dressers
American Emery Wheel Co., Providence, R. I.
Bay State Stamping Co., Worcester, Mass.
Desmond-Stephen Mfg. Co., Urbana, O.
Diamond Saw & Stamping Works, Buffalo, N. Y.
Dickinson, Thos. L., New York.
Safety Emery Wheel Co., Springfield, O.
Standard Tool Co., Cleveland, O.
Vitrified Wheel Co., Westfield, Mass.
Wrigley Co., Thos., Chicago, Ill.

Enclosures, Tool-room
Hart & Cooley Co., New Britain, Conn.
Merritt & Co., Philadelphia, Pa.

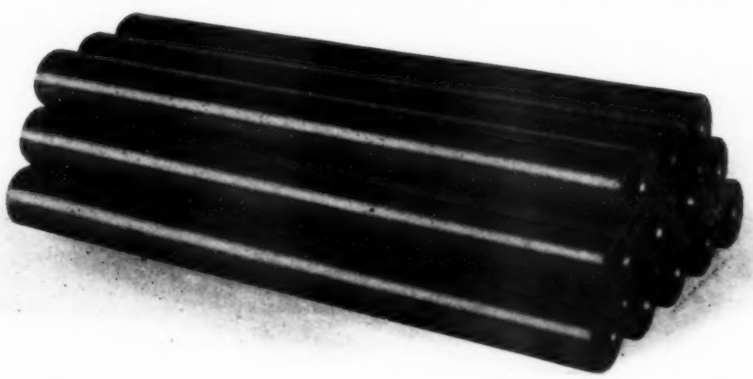
No. 23
Plain Grinding Machine

WITH AUTOMATIC FEEDS

12-inch swing, 42 inches between centers



LANDIS MACHINES FOR RESULTS



We are Grinding Specialists, and have experts at your service if you are at all interested.

Let us send you descriptive circulars.

Cast Iron Drum Pulleys: 3 inches diameter, 33 inches long, ground from the rough castings to a medium finish. Size within variation limit of .0005 inch—1/8 inch to 3-16 inch diameter removed. Average time taken, 20 minutes.

LANDIS TOOL COMPANY, Waynesboro, Pa., U. S. A.

AGENTS—Modern Machinery and Engineering Co., 309 Schofield Bldg., Cleveland, Ohio. Marshall & Huschart Machinery Co., 64 So. Canal St., Chicago, Ill. Walter H. Foster Co., 114 Liberty St., New York. C. W. Burton, Griffiths & Co., London. Schuchardt & Schutte, Berlin, Vienna, Stockholm, St. Petersburg. Alfred H. Schutte, Cologne, Brussels, Liege, Paris, Milan and Bilbao. A. R. Williams Machinery Co., Toronto. Williams & Wilson, Montreal, Canada.

Engineering Appliances
Crosby Steam Gage & Valve Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, O.

Engineers, Mechanical and Electrical
Crocker - Wheeler Co., Ampere, N. J.
Jackson, Henry Docker, Boston, Mass.
Merritt, Jos., Hartford, Conn.
Seaver, John W., Cleveland, O.

Engines, Gas and Gasolene
Automatic Mach. Co., Bridgeport, Conn.
Backus Water Motor Co., Newark, N. J.
Blaisdell Machinery Co., Bradford, Pa.
Grant Mfg. & Mach. Co., Bridgeport, Conn.
Struthers-Wells Co., Warren, Pa.

Engines, Motor
Franklin Mfg. Co., H. H., Syracuse, N. Y.
Ridgway Dynamo & Engine Co., Ridgway, Pa.

Engines, Steam
Garden City Fan Co., Chicago, Ill.
Struthers-Wells Co., Warren, Pa.
Sturtevant Co., B. F., Hyde Park, Mass.

Engraving Machinery
Gorton Mach. Co., Geo., Racine, Wis.

Exhaust Heads
Sturtevant Co., B. F., Hyde Park, Mass.

Exhibition, Machinery
Philadelphia Bourse, Phila., Pa.

Expanders, Tube
Nicholson & Co., W. H., Wilkes-Barre, Pa.

Eyelet Machinery
Manville Bros. Co., Waterbury, Conn.

Factory Equipment
Lyon Metallic Mfg. Co., Aurora, Ill.
Mfg. Equipment & Eng. Co., Boston, Mass.

Fans, Electric
Crocker - Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Northern Elec. Mfg. Co., Madison, Wis.
Sturtevant Co., B. F., Hyde Park, Mass.
Western Electric Co., Chicago, Ill.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Fans, Exhaust
Crocker - Wheeler Co., Ampere, N. J.
Garden City Fan Co., Chicago, Ill.
General Electric Co., Phila., Pa.
Sturtevant Co., B. F., Hyde Park, Mass.

Files and Rasps
American Swiss File & Tool Co., New York.
Barnett Co., G. & H., Phila., Pa.
Carver File Co., Philadelphia, Pa.
Hammacher, Schlemmer & Co., New York.
Nicholson File Co., Prov., R. I.
Reichhelm & Co., E. P., New York.
Simonds File Co., Fitchburg, Mass.

Filler, Iron
Clark Cast Steel Cement Co., Shelton, Conn.
Felton, Sibley & Co., Phila., Pa.

Filing Machines
Cochrane-Bly Co., Rochester, N. Y.
Henry & Wright Mfg. Co., Hartford, Conn.

Flexible Shafts
Chicago Flexible Shaft Co., Chicago, Ill.
Coates Clipper Mfg. Co., Worcester, Mass.
Gem Mfg. Co., Pittsburg, Pa.
Stow Mfg. Co., Binghamton, N. Y.

Forges
Boynton & Plummer, Worcester, Mass.
Bradley & Son, C. C., Syracuse, N. Y.
Burke Machy. Co., Cleveland, O.
Ingersoll-Rand Co., New York.
Miner & Peck Mfg. Co., New Haven, Conn.
National Machinery Co., Tiffin, O.
Prentiss Tool & Supply Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.

Forgings, Drop
Bethlehem Steel Co., So. Bethlehem, Pa.
Billings & Spencer Co, Hartford, Conn.
Bullard Auto. Wrench Co., Providence, R. I.
Crescent Forgings Co., Oakmont, Pa.
Krupp (Thos. Prosser & Son), New York.
O. K. Tool Holder Co., Shelton, Conn.
Williams & Co., J. H., Brooklyn, N. Y.

Forgings, Hydraulic
Bethlehem Steel Co., So. Bethlehem, Pa.

Forgings, Steel
Bethlehem Steel Co., So. Bethlehem, Pa.
Cammel, Laird & Co., New York.
Crescent Forgings Co., Oakmont, Pa.
Krupp (Thos. Prosser & Son), New York.
Tindel-Morris Co., Eddystone, Pa.

Foundry Furnishings
Adams Co., Dubuque, Iowa.
Byram & Co., Inc., Detroit, Mich.
Goldschmidt Thermit Co., New York.
Ingersoll-Rand Co., New York.
Obermayer Co., S., Cincinnati, O.
Paxson Co., J. W., Phila., Pa.
Stevens, F. B., Detroit, Mich.
Sturtevant Co., B. F., Hyde Park, Mass.

Furnaces, Annealing and Tempering
American Gas Furnace Co., New York.
Chicago Flexible Shaft Co, Chicago, Ill.
Nash Company, Geo., New York.
Tate, Jones & Co., Pittsburg, Pa.
Westmacott Gas Furnace Co., Providence, R. I.

Furnaces, Enameling
American Gas Furnace Co., New York.

Furnaces, Gas
American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.
Nash Company, Geo., New York.
Obermayer Co., S., Cincinnati, O.
Westmacott Gas Furnace Co., Providence, R. I.

Furnaces, Melting
American Gas Furnace Co., New York.
Nash Company, Geo., New York.
Westmacott Gas Furnace Co., Providence, R. I.

Furnaces, Oil
Tate, Jones & Co., Pittsburg, Pa.

Furniture, Machine Shop
Hart & Cooley Co., New Britain, Conn.
Lyon Metallic Mfg. Co., Aurora, Ill.
Manufacturing Equip. & Engineering Co., Boston, Mass.
Merritt & Co., Philadelphia, Pa.
New Britain Mach. Co., New Britain, Conn.

Gages, Recording
Bristol Co., Waterbury, Conn.

Gages, Standard
Ames & Co., B. C., Waltham, Mass.
Athol Machine Co., Athol, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.

Gages, Standard—*Continued.*
Cleveland Twist Drill Co., Cleveland, O.
Grönkvist Drill Chuck Co., Jersey City, N. J.
Henry & Wright Mfg. Co., Hartford, Conn.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Rogers Wks., Jno. M., Gloucester City, N. J.
Slocomb Co., J. T., Prov., R. I.
Starrett Co., L. S., Athol, Mass.
Wyke & Co., J., East Boston, Mass.

Gages, Steam
Bristol Co., Waterbury, Conn.
Crosby Steam Gage & Valve Co., Boston, Mass.

Gear Cutting Machinery
Adams Co., Dubuque, Iowa.
American Watch Tool Co., Waltham, Mass.
Becker-Brainard Milling Machine Co., Hyde Park, Mass.
Bickford Drill & Tool Co., Cincinnati, O.
Bilgram, Hugo, Philadelphia, Pa.
Brown & Sharpe Mfg. Co., Providence, R. I.
Clough, R. M., Tolland, Conn.
Eberhardt Bros. Mach. Co., Newark, N. J.
Fellows Gear Shaper Co., Springfield, Vt.
Foote Bros. Gear & Machine Co., Chicago, Ill.
Gleason Works, Rochester, N. Y.
Gould & Eberhardt, Newark, N. J.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Newton Machine Tool Wks., Inc., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Slate Machine Co., Dwight, Hartford, Conn.
Sloan & Chace Mfg. Co., Newark, N. J.
Spacke Mach. Co., F. W., Indianapolis, Ind.
Walcott & Wood Mach. Tool Co., Jackson, Mich.
Waltham Machine Works, Waltham, Mass.
Whiton Machine Co., D. E., New London, Conn.

Gear Testing Machinery
Gisholt Mach. Co., Madison, Wis.

Gears, Cut
Bilgram, Hugo, Philadelphia, Pa.
Boston Gear Works, Norfolk Downs, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Caldwell & Son Co., H. W., Chicago, Ill.
Chicago Raw Hide Mfg. Co., Chicago, Ill.
Davis, Rodney, Philadelphia, Pa.
Earle Gear & Machine Co., Philadelphia, Pa.
Eberhardt Bros. Mach. Co., Newark, N. J.
Fawcus Mach. Co., Pittsburg, Pa.
Fellows Gear Shaper Co., Springfield, Vt.
Foote Bros Gear & Machine Co., Chicago, Ill.
Gleason Works, Rochester, N. Y.
Gould & Eberhardt, Newark, N. J.
Grant Gear Wks., Boston, Mass.
Hardinge Bros., Chicago, Ill.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Horsburgh & Scott Co., The, Cleveland, Ohio.
Lea Equipment Co., New York.
Mutual Machine Co., Hartford, Conn.
New Process Rawhide Co., Syracuse, N. Y.
Nuttall Co., R. D., Pittsburg, Pa.
Patterson, Gottfried & Hunter, Ltd., New York.
Philadelphia Gear Works, Philadelphia, Pa.
Sawyer Gear Wks., Cleveland, O.
Spacke Mach. Co., F. W., Indianapolis, Ind.
Taylor-Wilson Mfg. Co., McKees Rocks, Pa.
Van Dorn & Dutton, Cleveland, O.
Walcott & Wood Mach. Tool Co., Jackson, Mich.
Waterbury Gear Co., Waterbury, Conn.

Gears, Molded
Caldwell & Son Co., H. W., Chicago, Ill.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Franklin Mfg. Co., H. H., Syracuse, N. Y.
Horsburgh & Scott Co., Cleveland, Ohio.
Philadelphia Gear Works, Philadelphia, Pa.
Taylor-Wilson Mfg. Co., McKees Rocks, Pa.

Gears, Rawhide
Boston Gear Works, Norfolk Downs, Mass.
Chicago Raw Hide Mfg. Co., Chicago, Ill.
Earle Gear & Mach. Co., Philadelphia, Pa.
Fawcus Mach. Co., Pittsburg, Pa.
Gould & Eberhardt, Newark, N. J.
Grant Gear Works, Boston, Mass.
Horsburgh & Scott Co., Cleveland, O.
New Process Rawhide Co., Syracuse, N. Y.
Nuttall Co., R. D., Pittsburg, Pa.
Philadelphia Gear Works, Philadelphia, Pa.
Sawyer Gear Works, Cleveland, O.

Gears, Worm
Albro-Clem Elevator Co., Philadelphia, Pa.
Boston Gear Works, Norfolk Downs, Mass.
Eberhardt Bros. Mach. Co., Newark, N. J.
Fawcus Mach. Co., Pittsburg, Pa.
Gould & Eberhardt, Newark, N. J.
Horsburgh & Scott Co., Cleveland, Ohio.
Nuttall Co., R. D., Pittsburg, Pa.
Philadelphia Gear Works, Philadelphia, Pa.
Taylor-Wilson Mfg. Co., McKees Rocks, Pa.
Van Dorn & Dutton, Cleveland, O.

Generating Sets
Burke Electric Co., Erie, Pa.
Crocker - Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Northern Electric Mfg. Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sturtevant Co., B. F., Hyde Park, Mass.
Triumph Elec. Co., Cincinnati, O.

Generators, Gas
American Gas Furnace Co., New York.

Gibs
Standard Gauge Steel Co., Beaver Falls, Pa.

Graphite
Dixon Crucible Co., Jos., Jersey City, N. J.
Obermayer Co., S., Cincinnati, O.

Grinders, Knife
American Wood Working Mchy. Co., Rochester, N. Y.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Safety Emery Wheel Co., Springfield, O.

Grinders, Center
Cincinnati Electrical Tool Co., Cincinnati, O.
Coates Clipper Mfg. Co., Worcester, Mass.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Gem Mfg. Co., Pittsburg, Pa.
Heald Mach. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cin., O.
Mueller Machine Tool Co., Cincinnati, O.
Niles-Bement-Pond Co., New York.
Stow Mfg. Co., Binghamton, N. Y.
U. S. Electrical Tool Co., Cin., O.

Grinders, Cutter
Bath Grinder Co., Inc., Fitchburg, Mass.
Becker-Brainard Milling Mach. Co., Hyde aPrk, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Milling Machine Co., Cincinnati, O.
Clark, Jr., Elec. Co., Inc., Jas., Louisville, Ky.
Crocker - Wheeler Co., Ampere, N. J.

Know all men by these presents

That we, **The Morse Twist Drill & Machine Co.,** a corporation duly organized under the laws of the Commonwealth of Massachusetts, and doing business at New Bedford, in the County of Bristol, in said Commonwealth; in consideration of good and current coin of the realm, in amounts as set forth in the catalog of said company—which can be readily obtained upon application—will give, grant, bargain, sell and convey unto dealers and users of Machinists' Tools, located in every part of the civilized world, certain tools (hereinafter mentioned) made of the best quality of steel, of fine finish and not excelled as to durability and accuracy.

Said tools consist of:

Drills, Reamers, Cutters, Chucks, Taps, Dies, Arbors, Counterbores, Countersinks, Gauges, Mandrels, Mills, Screw Plates, Sleeves, Sockets, Taper Pins and Wrenches.

TO HAVE AND TO HOLD said tools with all the privileges thereto belonging to their own use and behoof forever; that we have good right to convey the same as aforesaid, and that we will warrant and defend the same to said grantees.

IN WITNESS WHEREOF, WE, the said Morse Twist Drill & Machine Company, hereunto set our hand and seal this Sixth day of February, A.D. 1908.

L.S.

Morse Twist Drill & Machine Co.

Grinders, Cutter—*Continued.*
Garvin Machine Co., New York.
Gould & Eberhardt, Newark, N. J.
Heald Mach. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Ingersoll Milling Mach. Co., Rockford, Ill.
National Machine Co., Hartford, Conn.
Niles-Bement-Pond Co., New York.
Norton Grinding Co., Worcester, Mass.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Rivett Dock Co., Boston, Mass.
U. S. Electrical Tool Co., Cincinnati, Ohio.
Wilmarth & Morman Co., Grand Rapids, Mich.

Grinders, Cylindrical
Bath Grinder Co., Inc., Fitchburg, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Heald Mach. Co., Worcester, Mass.
Landis Tool Co., Waynesboro, Pa.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Norton Grinding Co., Worcester, Mass.

Grinders, Disk
Bath Grinder Co., Inc., Fitchburg, Mass.
Besly & Co., Chas. H., Chicago, Ill.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Diamond Machine Co., Providence, R. I.
Gardner Machine Co., Beloit, Wis.
Heald Mach. Co., Worcester, Mass.
Safety Emery Wheel Co., Springfield, O.
Taylor & Fenn Co., Hartford, Ct.

Grinders, Drill
Heald Mach. Co., Worcester, Mass.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Niles-Bement-Pond Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Tool Co., Cleveland, O.
U. S. Electrical Tool Co., Cincinnati, Ohio.
Wilmarth & Morman Co., Grand Rapids, Mich.

Grinders, Internal
Bath Grinder Co., Inc., Fitchburg, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Greenfield Mach. Co., Greenfield, Mass.
Heald Mach. Co., Worcester, Mass.
Landis Tool Co., Waynesboro, Pa.
Rivett Lathe Mfg. Co., Boston, Mass.
U. S. Electrical Tool Co., Cincinnati, O.

Grinders, Portable
Cincinnati Electrical Tool Co., Cincinnati, O.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Coates Clipper Mfg. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
U. S. Electrical Tool Co., Cin., O.

Grinders, Saw
Tindel-Morris Co., Eddystone, Pa.

Grinders, Surface
National Machine Co., Hartford, Conn.

Grinders, Tool
Armstrong Bros. Tool Co., Chicago, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Bath Grinder Co., Inc., Fitchburg, Mass.
Blount Co., J. G., Everett, Mass.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Brown & Sharpe Mfg. Co, Providence, R I.
Cincinnati Electrical Tool Co., Cincinnati, O.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Diamond Machine Co., Providence, R. I.
Gisholt Mach. Co., Madison, Wis.
Gould & Eberhardt, Newark, N. J.

Grinders, Tool—*Continued.*
Grant Mfg. & Mach. Co., Bridgeport, Conn.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Heald Mch. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Landis Tool Co., Waynesboro, Pa.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Mummert, Wolf & Dixon Co., Hanover, Pa.
Niles-Bement-Pond Co., New York.
Norton Grinding Co., Worcester, Mass.
Rivett Lathe Mfg. Co., Boston, Mass.
Rockford Drilling Mach. Co., Rockford, Ill.
Safety Emery Wheel Co., Springfield, O.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Tool Co., Cleveland, O.
U. S. Electrical Tool Co., Cin., O.
Vandyck Churchill Co., New York.
Vitrified Wheel Co., Westfield, Mass.
Whitney Mfg. Co., Hartford, Ct.
Wilmarth & Morman Co., Grand Rapids, Mich.

Grinding or Polishing Machinery
Abrasive Material Co., Philadelphia, Pa.
American Emery Wheel Co., Providence, R. I.
Barnes Co., W. F. & John, Rockford, Ill.
Bath Grinder Co., Inc., Fitchburg, Mass.
Besly & Co., Chas. H., Chicago, Ill.
Blount Co., J. G., Everett, Mass.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Brown & Sharpe Mfg. Co., Providence, R. I.
Builders Iron Foundry, Providence, R. I.
Burke Machy. Co., Cleveland, O.
Chicago Machine Tool Co., Chicago, Ill.
Cincinnati Electrical Tool Co., Cincinnati, O.
Clark, Jr., Elec. Co., Inc., Jas., Louisville, Ky.
Coates Clipper Mfg. Co., Worcester, Mass.
Crocker - Wheeler Co., Ampere, N. J.
Diamond Machine Co., Providence, R. I.
Gardner Mach. Co., Beloit, Mich.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Heald Mach. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Landis Tool Co., Waynesboro, Pa.
Marshall & Huschart Machry. Co., Chicago, Ill.
Monarch Emery & Cor. Wheel Co., Camden, N. J.
National Machine Co., Hartford, Conn.
Newton Mach. Tool Works, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Northern Electrical Mfg. Co., Madison, Wis.
Norton Grinding Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Safety Emery Wheel Co., Springfield, O.
Stow Mfg. Co., Binghamton, N. Y.
U. S. Electrical Tool Co., Cincinnati, O.
Vandyck Churchill Co., New York.
Vitrified Wheel Co., Westfield, Mass.

Grinding Wheels
Adams Co., Dubukue, Iowa.
American Emery Wheel Co., Providence, R. I.
Best & Co., L., New York.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Carborundum Co., Niagara Falls, N. Y.
Diamond Machine Co., Providence, R. I.
Monarch Emery & Cor. Wheel Co., Camden, N. J.
Niles-Bement-Pond Co., New York.
Norton Co., Worcester, Mass.
Safety Emery Wheel Co., Springfield, O.
Vitrified Wheel Co., Westfield, Mass.
Whitney Mfg. Co., Hartford, Ct.

Grindstones and Frames
Athol Machine Co., Athol, Mass.

Grindstones and Frames—*Continued.*
Cleveland Stone Co., The, Cleveland, O.
Niles-Bement-Pond Co., New York.
Norton Co., Worcester, Mass.

Gun Barrel Machinery
Diamond Machine Co., Providence, R. I.
Pratt & Whitney Co., Hartford, Conn.
Reed Co., F. E., Worcester, Mass.

Hammers, Drop
Billings & Spencer Co., Hartford, Conn.
Bliss Co., E. W., Brooklyn, N. Y.
Bradley & Son, C. C., Syracuse, N. Y.
Chambersburg Engineering Co., Chambersburg, Pa.
Gould & Eberhardt, Newark, N. J.
Miner & Peck Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Toledo Machine and Tool Co., Toledo, Ohio.
Waterbury Farrel Fdry. & Mach. Co., Waterbury, Conn.

Hammers, Pneumatic
Chicago Pneumatic Tool Co., Chicago, Ill.
Clayton Air Compressor Works, New York.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
Sampson & Co., Geo. H., Boston, Mass.
Sellers & Co., Inc., Wm., Philadelphia, Pa.

Hammers, Power
Beaudry & Co., Inc., Boston, Mass.
Bradley & Son, C. C., Syracuse, N. Y.
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Prentiss Tool & Supply Co., New York.

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Chambersburg Engineering Co., Chambersburg, Pa.
Crescent Forgings Co., Oakmont, Pa.
Marshall & Huschart Machinery Co., Chicago, Ill.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.

Handles, Machine Tool
Whitman & Barnes Mfg. Co., Chicago, Ill.

Hangers, Shafting
Link-Belt Co., Philadelphia, Pa.

Heaters, Feed Water
Sturtevant Co., B. F., Hyde Park, Mass.

Heating and Ventilating Apparatus
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Sturtevant Co., B. F., Hyde Park, Mass.

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American Gas Furnace Co., New York.
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Hobbing Machines, Worm
Gould & Eberhardt, Newark, N. J.
Pratt & Whitney Co., Hartford, Conn.

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Brown Hoisting Machinery Co., Cleveland, O.
Case Mfg. Co., Columbus, O.
Caldwell & Son Co., H. W., Chicago, Ill.
Cleveland Crane & Car Co., Wickliffe, O.
Link-Belt Co., Philadelphia, Pa.
Moore Co., Franklin, Winsted, Ct.
Niles-Bement-Pond Co., New York.

Hoisting and Conveying Machinery—*Continued.*
Sturtevant Co., B. F., Hyde Park, Mass.
Yale & Towne Mfg. Co., New York.

Hoists, Electric
C & C Electric Co., New York.
Case Mfg. Co., Columbus, O.
Chicago Pneumatic Tool Co., Chicago, Ill.
Cleveland Crane & Car Co., Wickliffe, O.
Crocker - Wheeler Co., Ampere, N. J.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Electric Co., New York.
General Pneumatic Tool Co., Montour Falls, N. Y.
Niles-Bement-Pond Co., New York.
Northern Engineering Works, Detroit, Mich.
Yale & Towne Mfg. Co., New York.

Hoists, Hand
Case Mfg. Co., Columbus, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Moore Co., Franklin, Winsted, Ct.
Nicholls, Wm. S., New York.
Yale & Towne Mfg. Co., New York.

Hoists, Pneumatic
Chicago Flexible Shaft Co., Chicago, Ill.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Pneumatic Tool Co., Montour Falls, N. Y.
Ingersoll-Rand Co., New York.
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Hones
Carborundum Co., Niagara Falls, N. Y.
Chicago Pneumatic Tool Co., Chicago, Ill.

Hose
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Desmond-Stephan Mfg. Co., Urbana, O.
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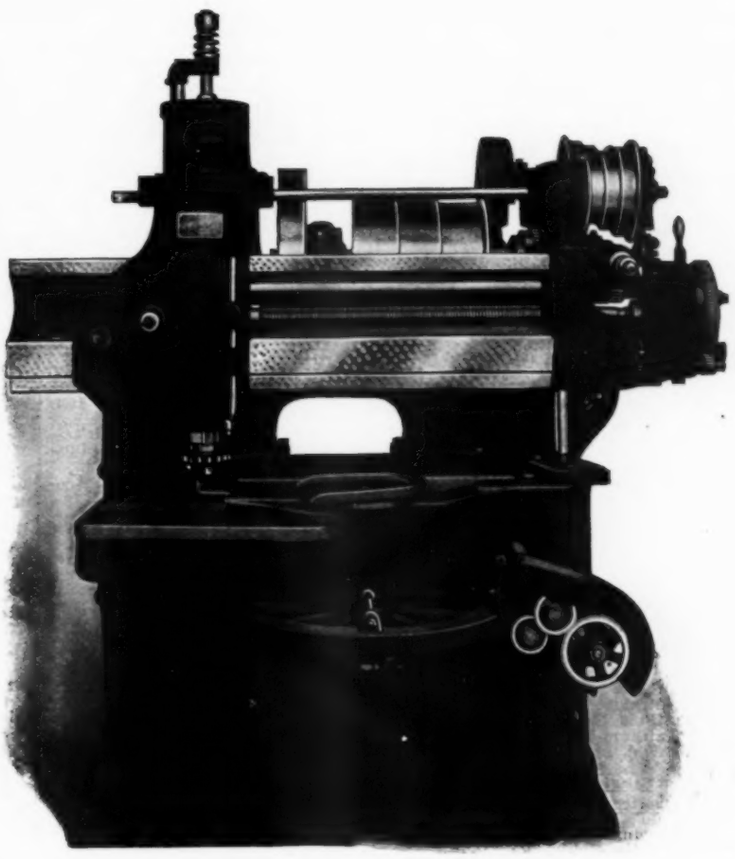

that it is apparent that it will soon be normal, although probably not abnormal. Are you ready for the return of business sanity and orders?

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Marshall & Huschart Machry. Co., Chicago, Ill.
Morton Manufacturing Co., Muskegon Heights, Mich.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Rockford Drilling Mach. Co., Rockford, Ill.
Whitney Mfg. Co., Hartford, Ct.

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Morse Twist Drill & Mach. Co., New Bedford, Mass.
Standard Gauge Steel Co., Beaver Falls, Pa.
Whitney Mfg. Co., Hartford, Ct.

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Coes Wrench Co., Worcester, Mass.
Simonds File Co., Fitchburg, Mass.

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General Electric Co., New York.
Turner Brass Works, Sycamore, Ill.
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Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

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Fitchburg Machine Works, Fitchburg, Mass.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
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Saunders Co., James, Dayton, O.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.
Sloan & Chace Mfg. Co., Newark, N. J.

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Armstrong Bros. Tool Co., Chicago, Ill.
Besly & Co., Chas. H., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
LeCount, Wm. G., So. Norwalk, Conn.
Pratt & Whitney Co., Hartford, Conn.
Tindel-Morris Co., Eddystone, Pa.
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Automatic Mach. Co., Bridgeport, Conn.
Barnes Co., W. F. & John, Rockford, Ill.
Blount Co., J. G., Everett, Mass.
Bradford Mach. Tool Co., Cin., O.
Bullard Mach. Tool Co., Bridgeport, Conn.
Champion Tool Works Co., Cincinnati, O.
Cincinnati Lathe and Tool Co., Cincinnati, O.
Davis Machine Co., W. P., Rochester, N. Y.
Dreses Mach. Tool Co., Cin., O.
Fay Mach. Tool Co., Phila., Pa.
Fitchburg Machine Works, Fitchburg, Mass.
Garvin Mach. Co., New York.
Gisholt Mach. Co., Madison, Wis.
Greaves, Klusman & Co., Cin., O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hendey Mach. Co., Torrington, Conn.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
Lodge & Shipley Mach. Tool Co., Cincinnati, O.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Moline Tool Co., Moline, Ill.
Morris Foundry Co., Jno. B., Cincinnati, O.
Motch & Merryweather Machinery Co., Cleveland, O.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.

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Prentiss Tool & Supply Co., New York.
Reed Co., F. E., Worcester, Mass.
Rockford Drilling Mach. Co., Rockford, Ill.
Saunders Co., James, Dayton, O.
Schumacher & Boye, Cincinnati, Ohio.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.
Springfield Mach. Tool Co., Springfield, O.
Tindel-Morris Co., Eddystone, Pa.
Vandyck Churchill Co., New York.
Von Wyck Mach. Tool Co., Cincinnati, O.
Walcott & Wood Mach. Tool Co., Jackson, Mich.
Whitcomb - Blaisdell Mach. Tool Co., Worcester, Mass.
Wormer Mchry. Co., C. C., Detroit, Mich.

Lathes, Automatic Screw-Threading
Automatic Machine Co., Bridgeport, Conn.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.

Lathes, Bench
American Watch Tool Co., Waltham, Mass.
Ames & Co., B. C., Waltham, Mass.
Blount Co., J. G., Everett, Mass.
Hardinge Bros., Chicago, Ill.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Rivett Lathe Mfg. Co., Boston, Mass.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.
Stark Tool Co., Waltham, Mass.
Sloan & Chace Mfg. Co., Newark, N. J.
Taylor & Fenn Co., Hartford, Conn.
Waltham Machine Works, Waltham, Mass.
Waltham Watch Tool Co., Springfield, Mass.

Lathes, Boring
American Wood Working Mchry. Co., Rochester, N. Y.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Lathes, Brass
Bardons & Oliver, Cleveland, O.
Dreses Mach. Tool Co., Cincin., O.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Springfield Mch. Tool Co., Springfield, O.
Warner & Swasey Co., Cleveland, Ohio.

Lathes, Extension
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.

Lathes, Foot Power
Barnes Co., W. F. & Jno., Rockford, Ill.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.

Lathes, Speed
Blount Co., J. G., Everett, Mass.
Chicago Machine Tool Co., Chicago, Ill.
Niles-Bement-Pond Co., New York.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.

Lathes, Wood
American Wood Working Mchy. Co., Rochester, N. Y.
Barnes Co., W. F. & John, Rockford, Ill.

Lathes, Wood—*Continued.*
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Seneca Falls Mfg. Co., Seneca Falls, N. Y.

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Starrett Co., L. S., Athol, Mass.

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Hart & Cooley Co., New Britain, Conn.
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Manufacturing Equipment & Engineering Co., Boston, Mass.

Locomotives, Electric
General Electric Co., New York.

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Coates Clipper Mfg. Co., Worcester, Mass.
Dixon Crucible Co., Jos., Jersey City, N. J.

Lubricators
Besly & Co., Chas. H., Chicago, Ill.
Gem Mfg. Co., Pittsburg, Pa.

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Lea Equipment Co., New York.
Manning, Maxwell & Moore, Inc., New York.
Marshall & Huschart Machry Co., Chicago, Ill.
McCabe, J. J., New York.
Motch & Merryweather Co., Cleveland, O.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Prentiss Tool & Supply Co., New York.
Toomey, Frank, Philadelphia, Pa.
Vandyck Churchill Co., New York.
Wormer Mach. Co., C. C., Detroit, Mich.

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Machine Screw Products Co., Providence, R. I.
Natl. Acme Mfg. Co., Cleveland, O.
Universal Machine Screw Co., Hartford, Conn.

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Bemis & Call Hardware & Tool Co., Springfield, Mass.
Besly & Co., Chas. H., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
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Hammacher, Schlemmer & Co., New York.
Handy Mfg. Co., Chicago, Ill.
Lufkin Rule Co., Saginaw, Mich.
Millers Falls Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Pratt & Whitney Co., Hartford, Conn.
Sawyer Tool Mfg. Co., Fitchburg, Mass.
Slocomb Co., J. T., Prov., R. I.
Standard Tool Co., Cleveland, O.
Starrett Co., L. S., Athol, Mass.

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Hammacher, Schlemmer & Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Magnets, Lifting
Electric Controller & Supply Co., Cleveland, O.

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Chadwick & Trefethen, Portsmouth, N. H.
Le Count, Wm. G., So. Norwalk, Conn.

Mandrels, Expanding—*Continued.*
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Nicholson & Co., W. H., Wilkes-Barre, Pa.
Western Tool & Mfg. Co., Springfield, O.

Mandrels, Solid
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Rogers Works, John M., Gloucester City, N. J.
Standard Tool Co., Cleveland, O.

Marking Machines
Slate Machine Co., Dwight, Hartford, Conn.

Measuring Machines
Pratt & Whitney Co., Hartford, Conn.
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Lumen Bearing Co., Buffalo, N. Y.
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Warner Instrument Co., Beloit, Wis.

Meters, Electric
General Electric Co., New York.

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Niles-Bement-Pond Co., New York.
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Whitney Mfg. Co., Hartford, Ct.

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American Watch Tool Co., Waltham, Mass.
Burke Machry. Co., Cleveland, O.
Niles-Bement-Pond Co., New York.
Rivett Lathe Mfg. Co., Boston, Mass.
Sloan & Chace Mfg. Co., Newark, N. J.
Waltham Watch Tool Co., Springfield, Mass.

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Brown & Sharpe Mfg. Co., Providence, R. I.
Chicago Machine Tool Co., Chicago, Ill.
Cincinnati Milling Mach. Co., Cincinnati, O.
Prentiss Tool & Supply Co., New York.
Whitney Mfg. Co., Hartford, Ct.

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Cincinnati Milling Machine Co., Cincinnati, O.
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Ingersoll Milling Mach. Co., Rockford, Ill.
Kempsmith Mfg. Co., Milwaukee, Wis.
Newton Machine Tool Works, Philadelphia, Pa.
Niles-Bement-Pond Co. New York.

A Hendey-Norton Lathe with typical Tool Room Equipment, consisting of Oil Pan, Taper Attachment, Relieving Attachment.

A word regarding the RELIEVING ATTACHMENT. The Tool Slide is shown set at an angle. In this position it can be used up to 30 degrees for backing off cutters having side cutting teeth, such as used for milling flutes in taps, reamers, etc. The tool room finds it necessary in many cases to make cutters of this character frequently, and without a Relieving Attachment that can be SET AT PROPER ANGLE TO OBTAIN THIS SIDE RELIEF, you are seriously handicapped. Of course, the ordinary backing off of taps, hobs, formed cutters, is quickly and accurately done with this same attachment.

It has but one fixed cam, different divisions being obtained with a few change gears, the travel of tool being variable at will.

Furnished on 14", 16", 18" lathes.

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Torrington, Conn.

"MILTON" Semi-Finished Nuts

NUTS OF BEST QUALITY.

Are Faced True at Right Angles with Bottom of Thread.

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Hendey Mach. Co., Torrington, Conn.
Kearney & Trecker, Milwaukee, Wis.
Kempsmith Mfg. Co., Milwaukee, Wis.
Le Blond Mach. Tool Co., R. K., Cincinnati, O.
McCabe, J. J., New York.
Marshall & Huschart Machry Co., Chicago, Ill.
Niles-Bement-Pond Co., New York.
Oesterlein Mach. Co., Cincin., O.
Owen Mach. Tool Co., Springfield, Ohio.
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Owen Mach. Tool Co., Springfield, Ohio.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.
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General Electric Co., New York.
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Ridgway Dynamo & Engine Co., Ridgway, Pa.
Roth Bros. & Co., Chicago, Ill.
Stow Mfg. Co., Binghamton, N. Y.
Sturtevant Co., B. F., Hyde Park, Mass.
Triumph Elec. Co., Cincinnati, O.
Wagner Elec. Mfg. Co., St. Louis, Mo.
Western Electric Co., Chicago, Ill.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

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Turner Brass Works, Sycamore, Ill.

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Lunkenheimer Co., Cincinnati, O.
Powell Co., Wm., Cincinnati, O.

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Bee Bolt and Nut Machinery.

Oils

Besly & Co., Chas., Chicago, Ill.

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Bay State Stamping Co., Worcester, Mass.
Gem Mfg. Co., Pittsburg, Pa.

Oxygen Welding

Industrial Oxygen Co., New York.

Packings, Hydraulic

Watson-Stillman Co., New York.

Packing, Steam

Jenkins Bros., New York.

Paints and Enamels, Machinery

Felton, Sibley Co., Phila., Pa.

Pans, Lathe

Lyon Metallic Mfg. Co., Aurora, Ill.
New Britain Mach. Co., New Britain, Conn.

Pans, Shop

Lyon Metallic Mfg. Co., Aurora, Ill.
New Britain Mach. Co., New Britain, Conn.

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Macdonald & Macdonald, New York.

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Straley & Hasbrouck, New York.

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Greaves, Klusman & Co., Cin., O.
Hammacher, Schlemmer & Co., New York.
Marston & Co., J. M., Boston, Mass.
Prentiss Tool & Supply Co., New York.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.
Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.

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Manville Bros. Co., Waterbury, Conn.
Moline Tool Co., Moline, Ill.
Mummert, Wolf, Dixon Co., Hanover, Pa.

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Lumen Bearing Co., Buffalo, N. Y.

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Stark Tool Co., Waltham, Mass.

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Curtis & Curtis Co., Bridgeport, Conn.
Foote-Burt Co., The, Cleveland, Ohio.
Landis Machine Co., Waynesboro, Pa.
Merrell Mfg. Co., Toledo, O.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Saunders Sons, D., Yonkers, N. Y.
Standard Engineering Works, Ellwood City, Pa.
Stoever Fdry. & Mfg. Co., Myerstown, Pa.
Vandyck Churchill Co., New York.
Wiley & Russell Mfg. Co., Greenfield, Mass.
Wrigley Co., Thos., Chicago, Ill.

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Goldschmidt Thermit Co., New York.
Reed Mfg .Co., Erie, Pa.
Saunders Sons, D., Yonkers, N. Y.
Standard Tool Co., Cleveland, O.

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Gray Co., G. A., Cincinnati, O.
Reed Co., F. E., Worcester, Mass.

Planer Tools

Armstrong Bros. Tool Co., Chicago, Ill.

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American Tool Wks. Co., Cin., O.
Betts Mach. Co., Wilmington, Del.
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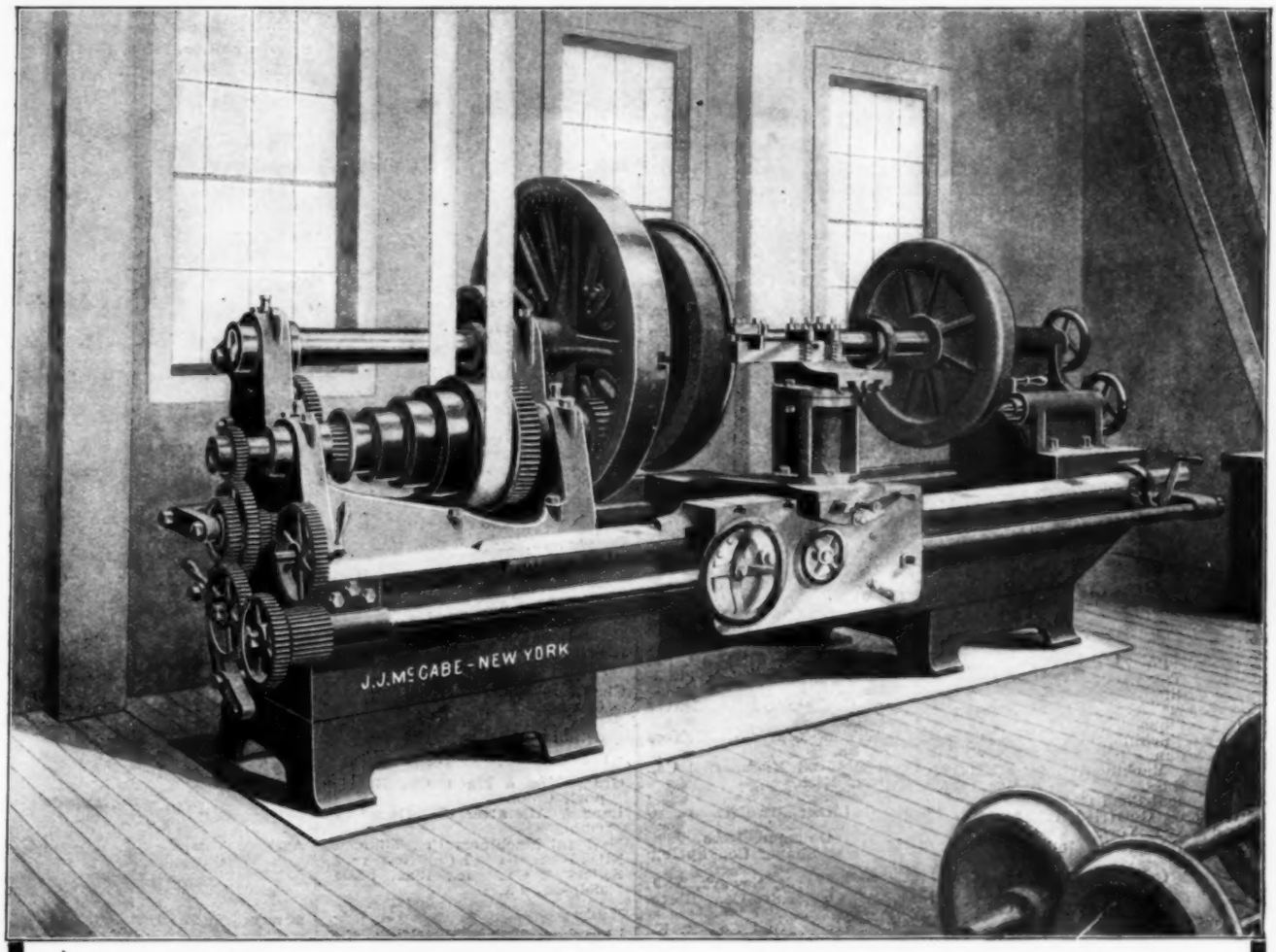

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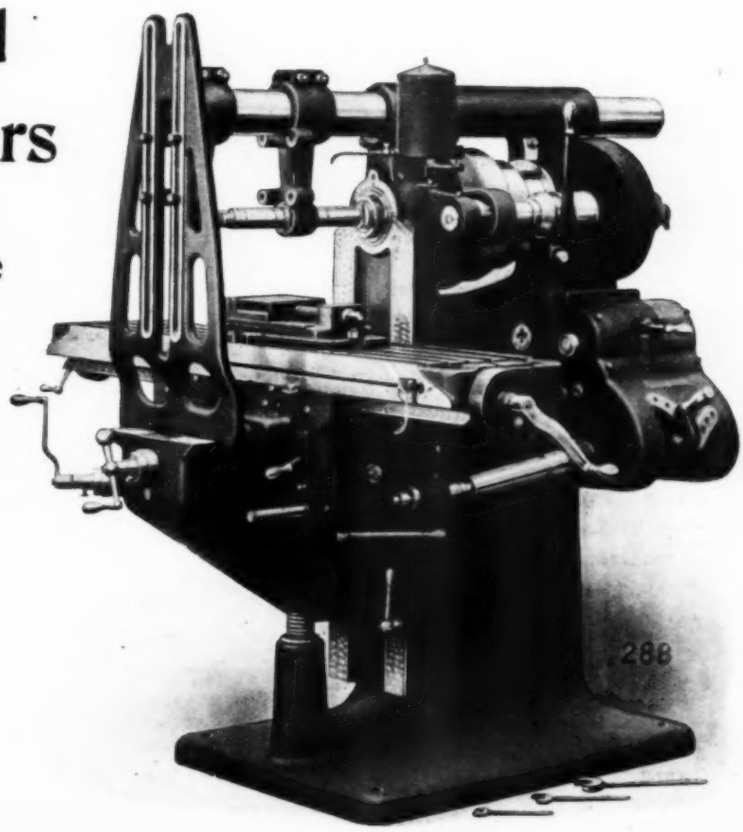

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Nash Company, Geo., New York.
Simonds File Co., Fitchburg, Mass.
Ward & Son, Edgar T., Boston, Mass.

Steel, Tool
American Tube & Stamping Co., Bridgeport, Conn.
Bethlehem Steel Co., So. Bethlehem, Pa.
Cammell, Laird & Co., New York.
Carpenter Steel Co., Reading, Pa.
Firth-Sterling Steel Co., Pittsburg, Pa.
Morton & Co., B. K., Sheffield, England.
Nash Company, Geo., New York.
Patterson ,Gottfried & Hunter, Ltd., New York.
Standard Gauge Steel Co., Beaver Falls, Pa.
Ward & Son, Edgar T., Boston, Mass.

Steel, Tempering and Hardening Solution
Metal Hardening Solution Co., Rochester, N. Y.

Stocks, Die
See Taps and Dies.

Stones, Oil
American Emery Wheel Co., Providence, R. I.
Carborundum Co., Niagara Falls, N. Y.
Norton Co., Worcester, Mass.
Vitrified Wheel Co., Westfield, Mass.

Stools, Shop
Cleveland Wire Spring Co., Cleveland, O.
Manufacturing Equip. & Engineering Co., East Boston, Mass.

Straightening Machinery
Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Fitchburg Machine Works, Fitchburg, Mass.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Niles-Bement-Pond Co., New York.
Springfield Machine Tool Co., Springfield, O.

Straighteners, Hydraulic
Burroughs Co., Chas., Newark, N. J.
Niles-Bement-Pond Co., New York.
Watson-Stillman Co., New York.

Straighteners, Shaft
Johnson & Bassett, Worcester, Mass.

Swaging Machines
Excelsior Needle Co., Torrington, Conn.

Switchboards
C & C Electric Co., New York.
Crocker - Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Western Electric Co., Chicago, Ill.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Switches
General Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

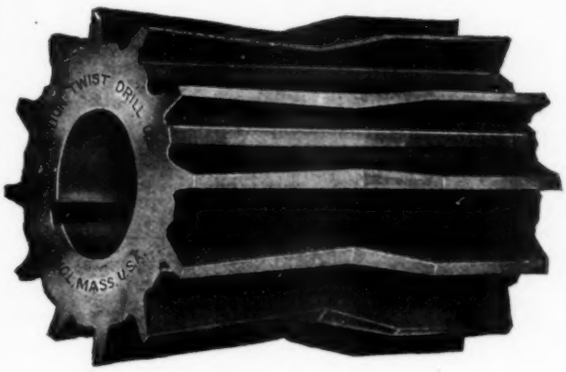
Tanks
Struthers-Wells Co., Warren, Pa.

Taper Pins
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.

Tapes, Measuring
Keuffel & Esser Co., New York.
Lufkin Rule Co., Saginaw, Mich.
Starrett Co., L. S., Athol, Mass.

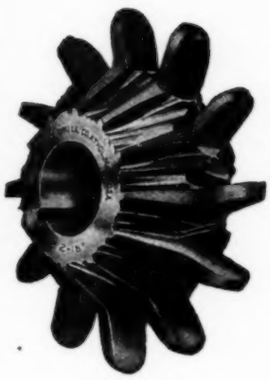
Tap Holders
Errington, F. A., New York.

Tapping Machines and Attachments
American Tool Works Co., Cin., Ohio.
Baker Brothers, Toledo, O.
Beaman & Smith Co., Prov., R. I.
Bickford Drill & Tool Co. ,Cin., O.
Burke Machry. Co., Cleveland, O.
Cincinnati Mach. Tool Co., Cincinnati, O.
Errington, F. A., New York.
Fosdick Mach. Tool Co., Cincinnati, O.
Garvin Mach. Co., New York.
Geometric Tool Co., New Haven, Conn.
Gould & Eberhardt, Newark, N. J.
Grant Mfg. & Mach. Co., Bridgeport, Conn.



No. 1

No. 1 End View



No. 2

Are You Doing As Well?

See Reports Below.

No. 2 End View

FORMED CUTTERS.

Cutters of this description have proved of great value in the production of pieces of irregular shape. The teeth are relieved in such a manner that it is only necessary to grind the faces to sharpen and so long as the face of the tooth is kept radial the shape milled will remain the same. They may be used until the teeth are worn very thin, in fact, so long as there is sufficient strength to the tooth to withstand the cutting strain.

We show here illustration of some which have performed a very satisfactory amount of service, showing how teeth have been ground away by repeated sharpening.

The No. 1 cutter has milled 7848 feet in machinery steel. The No. 2 cutter milled 16,000 pieces or a total of 1333 feet. Cutter milled to the full depth in cast iron, pieces being taken with the scale on them just as they come from the foundry. These cases are not exceptional. Are you getting such results?

We shall be pleased to furnish further information and quote prices on request.

UNION TWIST DRILL COMPANY,

The "Cutter Makers." :-: ATHOL, MASS.

New York Store—54 Warren St., W. L. Neff, Mgr. Boston Agents—25 Purchase St., E. T. Ward & Sons.
Philadelphia Store—52 N. 5th St., Field & Co., Mgrs. Chicago Store—54 W. Washington St., Bordwell & Barton Co.

FOREIGN AGENTS—France: Alfred H. Schutte, 85 Rue Reaumer, Paris. England: Chas. Neat & Co., 112 Queen Victoria St., London. Italy: Ing. A. Baldini & Co., Pontedera. Australia: Thos. McPherson & Sons, Melbourne. Japan: Andrews & George, Yokohama.

Tapping Machines and Attachments—*Continued.*
Marshall & Huschart Mfg. Co., Chicago, Ill.
National Machine Co., Hartford, Conn.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Sloan & Chace Mfg. Co., Newark, N. J.
Whitney Mfg. Co., Hartford, Ct.

Taps and Dies
Besly & Co., Chas. H., Chicago, Ill.
Brubaker & Bros., W. L., Millersburg, Pa.
Card Mfg. Co., S. W., Mansfield, Mass.
Carpenter Tap & Die Co., J. M., Pawtucket, R. I.
Cleveland Twist Drill Co., Cleveland, O.
Foote-Burt Co, Cleveland, Ohio.
Geometric Tool Co., New Haven, Conn.
Hammacher, Schlemmer & Co., New York.
Hardinge Bros., Chicago, Ill.
Hart Mfg. Co., Cleveland, O.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Nicholson & Co., W. H., Wilkes-Barre, Pa.
Patterson, Gottfried & Hunter, Ltd., New York.
Pratt & Whitney Co., Hartford, Conn.
Saunders Sons, D., Yonkers, N. Y.
Standard Tool Co., Cleveland, O.
Ward & Sons, Edgar T., Boston, Mass.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Taps, Collapsing
Geometric Tool Co., New Haven, Conn.

Telephones, Interior
Clark Auto. Telephone Switchboard Co., Providence, R. I.

Testing Machines
Sellers & Co., Inc., Wm., Philadelphia, Pa.

Tests and Consultation
Hunt Co., Robt. W., Chicago, Ill.

Thermit
Goldschmidt Thermit Co., New York.

Thermometers
Bristol Co., Waterbury, Conn.
Bristol, Wm. H., New York.

Thread Cutting Tools
Besly & Co., Chas. H., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Foote-Burt Co., Cleveland, O.
Hart Mfg. Co., Cleveland, O.
Pratt & Whitney Co., Hartford, Conn.
Rivett-Dock Co., Boston, Mass.
Rogers Works, John M., Gloucester City, N. J.
Western Tool & Mfg. Co., Springfield, O.

Tool Holders
Armstrong Bros. Tool Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Cleveland Twist Drill Co., Cleveland, O.
O. K. Tool Holder Co., Shelton, Conn.
Pratt & Whitney Co., Hartford, Conn.
Western Tool & Mfg. Co., Springfield, O.

Tools, Small
See Machinists' Small Tools.

Tracing Cloth
Keuffel & Esser Co., New York.

Transformers and Converters
Crocker - Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Wagner Elec. Mfg. Co., St. Louis, Mo.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Transmission Machinery
American Pulley Co., Phila., Pa.
Caldwell & Son Co., H. W., Chicago, Ill.
Case Mfg. Co., Columbus, O.
Coates Clipper Mfg. Co., Worcester, Mass.
Cowanesque Valley Iron Works, Cowanesque, Pa.
Link-Belt Co., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Rockwood Mfg. Co., Indianapolis, Ind.
Sellers & Co., Inc., Wm., Philadelphia, Pa.

Trolleys and Tramways
Brown Hoisting Machinery Co., Cleveland, O.
Chicago Pneumatic Tool Co., Chicago, Ill.
General Pneumatic Tool Co., Montour Falls, N. Y.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Link-Belt Co., Philadelphia, Pa.
Maris Bros., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Yale & Towne Mfg. Co., New York.

Trolley Wheels
Lumen Bearing Co., Buffalo, N. Y.

Trucks
Lyon Metallic Mfg. Co., Aurora, Ill.

Tubing, Steel
Almond Mfg. Co., T. R., Brooklyn, N. Y.
American Tube & Stamping Co., Bridgeport, Conn.
Shelby Steel Tube Co., Pittsburg, Pa.
Standard Welding Co., Cleveland, Ohio.
Ward & Sons, Edgar T., Boston, Mass.

Turntables
Sellers & Co., Inc., Wm., Philadelphia, Pa.

Turret Heads
Almond Mfg. Co., T. R., Brooklyn, N. Y.

Turrets, Carriage
Blount Co., J. G., Everett, Mass.

Turret Machines
Bardons & Oliver, Cleveland, O.
Bradford Mach. Tool Co., Cincinnati, O.
Brown & Sharpe Mfg. Co., Providence, R. I.
Bullard Mach. Tool Co., Bridgeport, Conn.
Davis Machine Co., W. P., Rochester, N. Y.
Dreses Mach. Tool Co., Cin., O.
Fay Mach. Tool Co., Phila., Pa.
Garvin Mach. Co., New York.
Gisholt Mach. Co., Madison, Wis.
Hill, Clarke & Co., Inc., Boston, Mass.
Jones & Lamson Machine Co., Springfield, Vt.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
Marshall & Huschart Machinery Co., Chicago, Ill.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentice Bros Co., Worcester, Mass.
Springfield Machine Tool Co., Springfield, O.
Warner & Swasey Co., Cleveland, Ohio.
Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.
Wood Turret Mach. Co., Terre Haute, Ind.

Turret Machines, Vertical
Bullard Mach. Tool Co., Bridgeport, Conn.

Twist Drills
Cleveland Twist Drill Co., Cleveland, O.
Hammacher, Schlemmer & Co., New York.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Nash Company, Geo., New York.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Standard Tool Co., Cleveland, O.
Ward & Son, Edgar T., Boston, Mass.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Twist Drills—*Continued.*
Wiley & Russell Mfg. Co., Greenfield, Mass.

Unions, Brass
Lunkenheimer Co., Cincinnati, O.
Nolte Brass Co., Springfield, O.

Universal Joints
Baush Mach. Tool Co., Springfield, Mass.
Blood Bros. Machine Co., Kalamazoo, Mich.
Boston Gear Works, Norfolk Downs, Mass.
Gould & Eberhardt, Newark, N. J.
Gray & Prior Mach. Co., Hartford, Conn.
Mutual Mach. Co., Hartford, Ct.

Valves
Crosby Steam Gage & Valve Co., Boston, Mass.
Jenkins Bros., New York.
Lunkenheimer Co., Cincinnati, O.

Ventilating Apparatus
Sturtevant Co., B. F., Hyde Park, Mass.

Vises, Drill
Graham Mfg. Co., Prov., R. I.
Plunket, J. E., Chicago, Ill.

Vises, Metal Workers'
Athol Machine Co., Athol, Mass.
Emmert Mfg. Co., Waynesboro, Pa.
Fulton Machine and Vise Co., Louisville, Ky.
Hammacher, Schlemmer & Co., New York.
Le Blond Mach. Tool Co., R. K., Cincinnati, O.
Millers Falls Co., New York.
Parker Co., Chas., Meriden, Conn.
Pittsburg Auto. Vise & Tool Co., Pittsburg, Pa.
Plunket, J. E., Chicago, Ill.
Prentiss Vise Co., New York.
Reed Mfg. Co., Erie, Pa.
Rock Island Tool Co., Rock Island, Ill.
Williamson Vise Co., Bradford, Pa.

Vises, Pipe
Bignall & Keeler Mfg. Co., Edwardsville, Ill.
Curtis & Curtis Co., Bridgeport, Conn.
Emmert Mfg. Co., Waynesboro, Pa.
Parker Co, Chas., Meriden, Conn.
Pittsburg Auto. Vise & Tool Co., Pittsburg, Pa.
Prentiss Vise Co., New York.
Reed Mfg. Co., Erie, Pa.
Rock Island Tool Co., Rock Island, Ill.
Saunders Sons, D., Yonkers, N. Y.
Williams & Co., J. H., Brooklyn, N. Y.
Williamson Vise Co., Bradford, Pa.

Vises, Planer and Shaper
American Tool Wks. Co., Cin., D.
Cincinnati Planer Co., Cincin., O.
Hendey Mach. Co., Torrington, Conn.
Niles-Bement-Pond Co., New York.
Queen City Machine Tool Co, Cincinnati, O
Williamson Vise Co., Bradford, Pa.

Vises, Universal Machine
Graham Mfg. Co., Prov., R. I.

Vises, Wood Workers'
American Wood Working Mchry. Co., Rochester, N. Y.
Fulton Machine and Vise Co., Louisville, Ky.
Hammacher, Schlemmer & Co., New York.
Parker Co., Chas., Meriden, Conn.
Pratt & Whitney Co., Hartford, Conn.

Vise Stands
Le Blond Mach. Tool Co., R. K., Cincinnati, O.
Tindel-Morris Co., Eddystone, Pa.

Voltmeter
Bristol Co., Waterbury, Conn.
Weston Elec. Instrument Co., Newark, N. J.

Washers
Milton Mfg. Co., Milton, Pa.

Wash Stands
Lyon Metallic Mfg. Co., Aurora, Ill.
Mfg. Equip & Engineering Co., East Boston, Mass.

Welding
Goldschmidt Thermit Co., New York.
Industrial Oxygen Co., New York.
Standard Welding Co., Cleveland, Ohio.

Welding, Electric
American Tube & Stamping Co., Bridgeport, Conn.
C & C Electric Co., New York.
Standard Welding Co., Cleveland, Ohio.

Wire
Phosphor Bronze Smelting Co., Philadelphia, Pa.

Wire, Music
Hammacher, Schlemmer & Co., New York.
Nash Co., Geo., New York.

Wire-Forming Machinery
Automatic Machine Co., Bridgeport, Conn.
Manville Bros. Co., Waterbury, Conn.
Smith, Chas. F., New York.

Wire Nail Machinery
National Machinery Co., Tiffin, O.

Wire-Straightening Machinery
Hoefer Mfg. Co., Freeport, Ill.
Prentiss Tool & Supply Co., New York.

Wood Working Machinery
American Wood Working Mchry. Co., Rochester, N. Y.
Greaves, Klusman & Co., Cin., O.
Prentiss Tool & Supply Co., New York.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.

Wrenches, Drop Forged
Billings & Spencer Co., Hartford, Conn.
Brown & Co., R. H., New Haven, Conn.
Whitman & Barnes Mfg. Co., Chicago, Ill.
Williams & Co., J. H., Brooklyn, N. Y.

Wrenches, Machinists'
Athol Machine Co., Athol, Mass.
Bemis & Call Hardware & Tool Co., Springfield, Mass.
Billings & Spencer Co., Hartford, Conn.
Brown & Co., R. H., New Haven, Conn.
Bullard Automatic Wrench Co., Providence, R. I.
Coes Wrench Co., Worcester, Mass.
Hammacher, Schlemmer & Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Tudor Mfg. Co., Taunton, Mass.
Whitman & Barnes Mfg. Co., Chicago, Ill.
Williams & Co., J. H., Brooklyn, N. Y.

Wrenches, Pipe
Bemis & Call Hardware & Tool Co., Springfield, Mass.
Bullard Automatic Wrench Co., Providence, R. I.
Patterson, Gottfried & Hunter, Ltd., New York.
Reed Mfg. Co., Erie, Pa.
Whitman & Barnes Mfg. Co., Chicago, Ill.
Williams & Co., J. H., Brooklyn, N. Y.

Wrenches, Ratchet
Bullard Automatic Wrench Co., Providence, R. I.
Parker Co., Chas., Meriden, Conn.
Pratt & Whitney Co., Hartford, Conn.
Tudor Mfg. Co., Taunton, Mass.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Wrenches, Tap
Besly & Co., Chas. H., Chicago, Ill.
Card Mfg. Co., S. W., Mansfield, Mass.
Carpenter Tap & Die Co., J. M., Pawtucket, R. I.
Hart Mfg. Co., Cleveland, O.
Sawyer Tool Mfg. Co., Fitchburg, Mass.
Standard Tool Co., Cleveland, O.
Starrett Co., L. S., Athol, Mass.